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ABSTRACT

This packet contains an Instructor guide and student reference for a course in introduction to grassland management, as well as a crop and grassland plant identification manual. The three-unit curriculum contains the following 11 lessons: (unit I, grasslands and grassland plants): (1) an introduction to grasslands; (2) plant classification; (3) botanical characteristics; (4) grassland composition; (unit II, soil management): (1) soil tests; (2) using soil survey manuals; (unit III, grassland management, practices): (1) grasslands and the nutritional needs of livestock; (2) grazing management systems; (3) harvesting and storing forage crops; (4) wildlife management; and (5) grassland management plan. The instructor guide includes objectives, competencies, motivational techniques, teaching procedures, other activities, activity sheets, transparency masters, evaluations, answers to evaluations and activity sheets, references and teaching aids, and materials and equipment lists. In addition, 35 references are listed. A competency profile is provided in the front of the guide for convenient recordkeeping, and an appendix provides a glossary of 150 selected terms for conservation and resource use. The student reference contains information sheets and summaries for each of the lessons, while the Plant Identification Manual includes drawings and descriptions on grasses and grasslike plants, legumes, forbs, and perennial woody plants. (KC)

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**Introduction to Grassland Management
Instructor Guide
Student Reference**

**Crop and Grassland
Plant Identification Manual**

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INTRODUCTION TO GRASSLAND MANAGMENT

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FOREWORD

The development of the *Introduction to Grassland Management* curriculum guide is the result of suggestions by the MVATA Teaching Aids Committee. The Grassland Management Advisory Committee suggested the topics to be included and reviewed the materials.

This three-unit curriculum contains 11 lessons. The instructor guide includes: objectives, competencies, motivational techniques, teaching procedures, other activities, activity sheets, transparency masters, evaluations, answers to evaluations and activity sheets, references and teaching aids, and materials and equipment. Topics include grasslands and grassland plants, soil management, and grassland management practices. A glossary with additional terms related to grassland management has been included for the use of the instructor. One copy of the student reference is packaged with the instructor's guide. Additional copies of the student reference can be purchased separately. IML's *Crop and Grassland Plant Identification Manual* was designed to accompany the *Introduction to Grassland Management* curriculum as a reference to common species of grasses, legumes, forbs, and woody plants.

During the summer of 1981, the Missouri State Board of Education formally adopted the concept of "Instructional Management Systems" (IMS) as a priority for the 1981-82 school year. The Missouri Commissioner of Education described the IMS concept as a practical way of "organizing for excellence" in education. To meet the demand for greater productivity and accountability, the director of Vocational Education applied the elements of IMS to form the Vocational Instructional Management System (VIMS). The VIMS process provides a framework to use in planning and organizing to assure excellence in Missouri's vocational education system by focusing greater attention on the management of teaching and learning.

This guide incorporates the needed components to aid agriculture teachers in the implementation of VIMS. For ease of use, performance objectives and competencies have been included at the beginning of the guide as well as incorporated within each lesson. A competency profile has been provided in the front of the guide for convenient record keeping.

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INTRODUCTION TO GRASSLAND MANAGEMENT

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COMPETENCIES/OBJECTIVES

UNIT I - GRASSLANDS AND GRASSLAND PLANTS

1. Identify different types of grasslands and explain factors that create them.
2. Identify plant classifications found in grasslands.
3. Recognize the characteristics of grassland plants that are used in plant identification.
4. Appraise the current conditions of the grassland.

UNIT II - SOIL MANAGEMENT

1. Interpret soil test information.
2. Interpret soil survey manuals and recommend plants for a soil type.

UNIT III - GRASSLAND MANAGEMENT PRACTICES

1. Analyze the nutrient needs of livestock.
2. Determine the optimal grazing methods for a grassland.
3. Determine methods for harvesting and storing forage crops.
4. Develop a better understanding of the management practices needed to manage both livestock and wildlife on grasslands.
5. Develop a grassland management plan.

EVALUATION

1. Give short, objective tests following each lesson and a more in-depth objective test at the conclusion of the unit.
2. Observe the changes in behavior as evidence of the improved ability of students to deal with problems in this unit using background information acquired from earlier units.
3. Observe students' attempts to solve similar problems in their supervised agricultural experience programs.

REFERENCES AND MATERIALS

1. Student Reference

Introduction to Grassland Management (Student Reference). University of Missouri-Columbia: Instructional Materials Laboratory, 1997.

2. Teacher References

a. Books

- 1) Barnes, Robert F., Darrell A. Miller, and C. Jerry Nelson. *Forages, Volume I: An Introduction to Grassland Agriculture*. 5th ed. Ames: Iowa State University Press, 1995.
- 2) Blakely, James, and David H. Bade. *The Science of Animal Husbandry*. 5th ed. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1990.
- 3) Coambes, Howard, John Jennings, and David E. Pitts. *Grassland Evaluation Contest Study Guide*. University of Missouri-Columbia: Instructional Materials Laboratory, 1998.
- 4) Dent, David, and Anthony Young. *Soil Survey and Land Evaluation*. London: Allen & Unwin, 1981.
- 5) Donahue, Roy L., Roy Hunter Miller, and John C. Schickluna. *Soils: An Introduction to Soils and Plant Growth*. 5th ed. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1983.
- 6) Donahue, Roy L., Roy Hunter Follett, and Rodney W. Tulloch. *Our Soils and Their Management*. Danville, Ill.: Interstate Publishers, Inc., 1990.
- 7) Heath, Maurice E., et al. *Forages*. Ames: Iowa State University Press, 1974.
- 8) Hitchcock, A. S. *Manual of the Grasses of the United States*. 2nd ed. 2 vols. New York: Dover Publications, Inc., 1971.
- 9) Humphrey, John Kevin. *Plant Science*. University of Missouri-Columbia: Instructional Materials Laboratory, 1991.
- 10) Minor, Paul E. *Soil Science*. University of Missouri-Columbia: Instructional Materials Laboratory, 1995.
- 11) Nelson, Paul W. *The Terrestrial Natural Communities of Missouri*. Jefferson City: Missouri Department of Natural Resources, 1985.
- 12) Odum, Eugene P. *Fundamentals of Ecology*. Philadelphia: W.B. Saunders Publishing, 1971.
- 13) Rider, Allen, and Stephen Barr. *Fundamentals of Machine Operation: Hay and Forage Harvesting*. Moline, Ill.: Deere and Company, 1976.
- 14) Rodekohl, Sherie, and Debi Waeckerle. *Landscaping and Turf Management*. University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
- 15) Smith, Dale, Raymond Bula, and Richard Walgenbach. *Forage Management*. 5th ed. Dubuque: Kendall/Hunt, 1986.
- 16) Vallentine, John F. *Grazing Management*. San Diego: Academic Press, 1990.
- 17) Walton, Peter D. *Production and Management of Cultivated Forages*. Reston, Va.: Reston Publishing Company, Inc., 1983.

b. Pamphlets, magazines, etc.

- 1) Hermel, Shauna Rose. "Calculating Grass Needs." *Beef* 32 (1996): 16-17.
- 2) University Extension agricultural publications, University of Missouri-Columbia.
 - a) G9102: *Liming Missouri Soils*
 - b) G9110: *How to Get a Good Soil Sample*
 - c) G9111: *Using Your Soil Test Results*
 - d) G9112: *Interpreting Missouri Soil Test Reports*

c. Government documents

- 1) Castilon, David A. *Soil Formation and Distribution in Missouri*. Conservation Education Series. Jefferson City: Missouri Department of Conservation, 1984.
- 2) Castilon, David A., and Jack C. Woodhead. *Biogeography of Missouri*. Conservation Education Series. Jefferson City: Missouri Department of Conservation, 1991.
- 3) Pitts, David E., and William McGuire. *Wildlife Management for Missouri Landowners*. Jefferson City: Conservation Commission of the State of Missouri, 1991.
- 4) Shroeder, Walter A. *Presettlement Prairies of Missouri*. Natural History Series, no. 2. Jefferson City: Missouri Department of Conservation, 1982.
- 5) Woodhead, Jack C. *Prairie Life of Missouri*. Jefferson City: Missouri Department of Conservation, 1991.

d. Internet resources

- 1) Emmick, Darrell L., and Danny G. Fox. "Intensity and Timing of Grazing." *Prescribed Grazing Management to Improve Pasture Productivity in New York*. <http://wwwscas.cit.cornell.edu/forage/pasture/intengraz.html> (7 May 1997).
- 2) Forage Information System. "Chemical Analysis." [http://www.forages.css.orst.edu/Topics/FQT/Chemical analysis](http://www.forages.css.orst.edu/Topics/FQT/Chemical%20analysis) (12 March 1997).
- 3) Forage Information System. "What is Quality?" <http://www.forages.css.orst.edu/Topics/FQT/WIQ/index.html> (12 March 1997).
- 4) Hall, Marvin H. "Putting Forage Quality in Perspective." <http://www.cas.psu/docs/casdept/agronomy/forage/docs/quality/perspective.html> (12 March 1997).
- 5) Hannaway, D. B., and P. J. Ballerstedt. "Testing the Quality of Alfalfa Hay." <http://www.forages.css.orst.edu/Resource...Publications/Species/Alfalfa/PNW223.html> (7 March 1997).
- 6) *Lab 2: Vegetative Characters*. <http://csdl.tamu.edu/FLORA/tfplab/vegchar.htm> (3 July 1997).
- 7) Mackenzie, Betsy, and John Frett. *Glossary of Taxonomic Terms Commonly Employed in the Identification of Woody Plants*. <http://bluehen.ags.udel.edu/gopher-data2/botanicgarden/.glossary.txt> (3 July 1997).
- 8) Rayburn, Edward B. "Principles of Grazing Management." <http://www.caf.wvu.edu/~forages/5710.htm> (8 May 1997).

- 9) Schroeder, J. W. "Interpreting Forage Analysis (AS-1080)." North Dakota State University extension publication May 1994. <http://www.ext.nodak.edu/extpubs/plantsci/hay/r1080w.html> (12 March 1997).
- 10) Thiex, Nancy, and Ed Twidwell, "Interpreting Forage Analysis." <http://www.sdstate.edu/~cm10/http/INTERP.HTML> (12 March 1997).
- 11) Trotter, David J., and Keith D. Johnson. "Forage Testing: Why, How, and Where." <http://www.css.orst.edu/Topics/FQT/Publications/Forage.html> (17 March 1997).

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TEACHING CALENDAR

	Periods for Classroom Instruction/Activities	Length for Activity Sheets (AS)
Unit I, Lesson 1	1	AS 1.1 30 min.
Unit I, Lesson 2	3	AS 2.1 30 min.
		AS 2.2 2 class periods
Unit I, Lesson 3	4	No activity
Unit I, Lesson 4	2	AS 4.1 1 class period
Unit II, Lesson 1	2	AS 1.1 30 min.
		AS 1.2 1 class period
Unit II, Lesson 2	4	No activity
Unit III, Lesson 1	2	AS 1.1 30 min.
Unit III, Lesson 2	3	AS 2.1 1 class period
Unit III, Lesson 3	2	AS 3.1 30 min.
Unit III, Lesson 4	3	JS 4.1 1 class period
		JS 4.2 1 class period
Unit III, Lesson 5	4	JS 5.1 1 class period
		JS 5.2 1 class period

INTRODUCTION TO GRASSLAND MANAGEMENT

Competency Profile

Directions: Evaluate the student by checking the appropriate number or letter to indicate the degree of competency. The rating for each task should reflect **employability readiness** rather than the grades given in class.

Rating Scale: **3 Mastered** - can work independently with no supervision
2 Requires Supervision - can perform job completely with limited supervision
1 Not Mastered - requires instruction and close supervision
N No Exposure - no experience or knowledge in this area

3	2	1	N

A. Grasslands and Grassland Plants

1. Identify different types of grasslands and explain factors that create them.
2. Identify plant classifications found in grasslands.
3. Recognize the characteristics of grassland plants that are used in plant identification.
4. Appraise the current conditions of the grassland.

Other: _____

3	2	1	N

B. Soil Management

1. Interpret soil test information.
2. Interpret soil survey manuals and recommend plants for a soil type.

Other: _____

3	2	1	N

C. Grassland Management Practices

1. Analyze the nutrient needs of livestock.
2. Determine the optimal grazing methods for a grassland.
3. Determine methods for harvesting and storing forage crops.
4. Develop a better understanding of the management practices needed to manage both livestock and wildlife on grasslands.
5. Develop a grassland management plan.

Other: _____

INTRODUCTION TO GRASSLAND MANAGEMENT

[illegible]

UNIT I - GRASSLANDS AND GRASSLAND PLANTS

1. Identify different types of grasslands and explain factors that create them.
2. Identify plant classifications found in grasslands.
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UNIT II - SOIL MANAGEMENT

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UNIT I - GRASSLANDS AND GRASSLAND PLANTS

Lesson 1: An Introduction to Grasslands

Competency/Objective: Identify different types of grasslands and explain factors that create them.

Study Questions

1. What is a grassland?
2. What are forages?
3. What natural factors affect the creation of grasslands?
4. What are native grasslands?
5. What is a prairie?
6. What is a glade?
7. What is a savanna?
8. What are managed grasslands?
9. What is grassland management?
10. What is grassland conservation?

References

1. *Introduction to Grassland Management (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1997, Unit I.
2. Transparency Master
 - a) TM 1.1: A Missouri Glade
3. Activity Sheet
 - a) AS 1.1: Word Search

UNIT I - GRASSLANDS AND GRASSLAND PLANTS

Lesson 1: An Introduction to Grasslands

TEACHING PROCEDURES

A. Introduction

Grasslands are very important to agriculture in Missouri, since they supply more than half of the feed for the livestock raised by producers. Many factors, including both natural conditions and human intervention, work together to determine where grasslands occur. These factors also affect the type of grassland found in a particular area. Good management is the key to using this natural resource productively.

B. Motivation

1. Ask students what they think a grassland is. List their answers and discuss them. If possible, use slides to visually represent grasslands. Ask the following questions. Is an area a grassland if food for livestock is not raised on it? [Yes.] Is prairie grassland? [Yes.] Is a cornfield grassland? [Ecologically yes, agriculturally no.] What about your front yard? [Yes.]
2. Have students observe a lawn and explain what actions must take place to establish and maintain the area in grass. Have them answer the following questions. What would happen if weed control stopped? What would happen if mowing stopped? Have students visit another type of grassland convenient for them (pasture, prairie, glade) and evaluate it in the same way.

C. Assignment

D. Supervised Study

E. Discussion

1. Ask students for a definition of grassland. Discuss the different meanings of the word.

What is a grassland?

- a) Ecologically, a plant community dominated by grasses, whether they exist naturally or because of management practices
 - b) Agriculturally, an area managed to grow grass, legumes, or other pasture or range plants used mostly for the production of forage
2. Ask students to name some of the plants they consider to be forages. Discuss the definition of forages.

What are forages?

Forages are primarily grasses and legumes grown for their soft, vegetative parts, which are used as feed for livestock.

3. Ask students to list natural factors that affect grasslands. Discuss the different factors.

What natural factors affect the creation of grasslands?

- a) Climate
 - 1) Grasslands usually dominate in areas averaging 10 to 30 inches of rainfall.

- 2) Most of Missouri receives 35 inches of precipitation or more each year, which places the state at the transition point between grassland and forest.
 - b) Soil - Some soils (such as shallow or coarsely textured soils, hardpans, and soils with high water tables) discourage tree growth and favor grasslands.
 - c) Plants
 - 1) Many grassland plants have adapted to their environment by becoming dormant when conditions are harsh and producing new growth when conditions improve.
 - 2) This adaptation allows them to survive damage from fire, grazing/browsing, drought, and high winds, all of which can kill or limit the growth of trees and shrubs.
 - d) Grazing
 - 1) Grazing is natural to grassland communities.
 - 2) Unlike trees and shrubs, which are more severely damaged by grazing and browsing, grassland plants have adapted to grazing.
 - e) Fire
 - 1) Grassland plants tolerate fire better than trees and shrubs.
 - 2) Where fires occur often enough to limit forest, grasslands dominate.
4. Ask students to explain what native grasslands are. Discuss the changes European settlers and modern agriculture made to the ecology and landscape of Missouri.

What are native grasslands?

- a) Native grasslands are those that existed in America before the arrival of European settlers.
 - b) The trend toward conservation farming has led to new interest in native grasslands and their plants.
 - c) Most of Missouri's native grasslands are prairies, glades, or savannas.
5. Ask students to describe what a prairie is. If possible, show them pictures of a prairie.

What is a prairie?

- a) Prairies are large, continuous native grasslands in which trees and shrubs are nearly absent.
 - b) While grasses dominate, a rich diversity of native grasses, legumes, and forbs inhabit Missouri's remaining prairies.
 - c) Different kinds of prairies develop on different sites.
 - 1) Dry
 - (a) Dominated by shorter grasses like little bluestem and sideoats grama
 - (b) Mostly converted to pasture
 - 2) Wet
 - (a) Dominated by taller grasses like big bluestem and Indiangrass, sometimes reaching six to eight feet in height
 - (b) Mostly converted to cropland
6. Ask the following question: "While admiring a blossoming yucca, you fall from your horse, land seat first on a cactus, get stung by a scorpion, bitten by a tarantula, and struck by a rattlesnake. Aside from a world of hurt, where are you?" Point out that the answer could be a Missouri glade. Show TM 1.1 depicting a glade.

What is a glade?

- a) Small, isolated native grasslands occurring on hilltops and southwest-facing slopes
- b) Found where rocky outcrops, exposure to sunlight, and thin, dry soils create harsh desert-like conditions during the summer
- c) Dominated by prairie grasses and forbs
- d) Also have plants and animals from western prairies and deserts like yuccas, cacti, tarantulas, and scorpions

7. Ask students to describe a savanna. When woodlands and grasslands meet, the sudden presence of trees may look like a distinct change, but actually a more gradual transition is taking place. Grasslands with widely spaced trees and woodlands with a healthy stand of grass beneath the trees were common in presettlement Missouri.

What is a savanna?

- a) Specialized community that is intermediate between grassland and forest with widely spaced trees, a conspicuous absence of smaller trees and shrubs, and grasses as the dominant ground cover
 - b) Can be used for wood, wildlife habitat, and forages
8. Point out that few native grasslands with their original plant communities are left in Missouri, yet grasslands can be easily found in every part of the state. Ask students about the origin of these grasslands.

What are managed grasslands?

- a) Managed grasslands are areas managed for forage, pasture, or grassland habitat.
 - b) Over 95 percent of Missouri's grasslands are privately owned.
 - c) Most managed grasslands are used for forage production; pasture is the most common type of grassland in Missouri.
9. Discuss how grasslands are used today. Have students list factors involved in establishing and maintaining a grassland.

What is grassland management?

- a) Grassland management is the use and care of grasslands.
 - b) It involves managing the plants, animals, equipment, and practices needed for the successful use of grasslands.
10. Ask the class whether grasslands are a natural resource. Have students list other natural resources found on grasslands (soil, water, wildlife, plants). Discuss why conservation is important. Have students complete AS 1.1.

What is grassland conservation?

Grassland conservation is the wise use of grasslands and other natural resources found on them to insure their long-term productivity and sustainability.

F. Other Activities

1. Visit a prairie, glade, or savanna to distinguish between grasslands and other vegetation types. Emphasize the differences between native grasslands and converted grasslands.
2. Have students read "The Prairie Link" in *Public Prairies of Missouri* by Thomas E. Toney, published by the Missouri Department of Conservation.
3. Show range maps for the Eastern collared lizard, brush mouse, roadrunner, and prairie ringneck snake as examples of western desert and prairie species that live in glades in Missouri.
4. Show a video from the MDC Media Library to the class: "Prairie Dancers" (10½ min., 1986); "Natural Divisions" (5¾ min., 1996), from the video collection *Plants, Flowers, & Places II*; "Prairie Burn" (3½ min., 1996), part of the video collection *Prairies*; or "Glade Burn" (6½ min., 1996) part

of the video collection *Plants, Flowers, & Places II*. "Natural Divisions," "Prairie Burn," and "Glade Burn" are from the *Missouri Outdoors* television series.

5. Have students visit a pasture and write a description of it, mentioning the amount of ground cover, the density of the plants, the amount of bare soil, signs of erosion, and the height and quality of the forage. Read descriptions of native grasslands (perhaps from *Presettlement Prairie of Missouri* by Walter A. Schroeder, published by the Missouri Department of Conservation). Compare these descriptions and ask students which land they would prefer to own. What do they think can be done to improve forage production on the pasture they observed?

G. Answers to Activity Sheet

H H A B E C L I N T D N L L K B C R H A G J E P F I R A W
M A N T Q G R S A V C S S S E Z O A R K R T M O B O E A C
F A B D V N O R P L L O U A G G N D I N A O O P T I R K S
F O R I K S O N I B R Y S V A P M E L T S N W I L B M B L
E M O X T I A S I T Y M T E G L A D E I S O N R S J D Z S
Q G D N T A C L I V S A A G R A C R F S L D I N T B Y P H
B O A S O S T O N B L N I M A L S O S N A W M L O T E B M
M L I V B E O A T I N A N I Z Y H A Z C N C O R H A R S G
P L A K G U M O W I N G A N P E A R E K D O E G N M E O R
S P E N K W R L A N B E B G H R B G L S A N A N V R C K A
O H I C D V M S E R O M I L G N A T T I Y Z A O B O H M Z
C L O R I T I D I O N E L A S R H O P L I V E S T O C K I
A M P G A S S I N R X N I D O R P B R N A T V E S S G U N
P R A I R I E V P C O T T F T O N R B S J D Q E C H R L G
L A M O R K D E A I T Z Y S R D A O O U T A T B L I T E Y
A N T A O I N A T E O B O R T R S A K D X L A S I D Y G P
H A I L B T P A Y R V A F I P R U D V E U L K O M A B U R
I T M C A T V B P U B T I P O S S L E W D C K N A L X M O
J I H Q O R N D O T Q W R X A A C E V E G E T A T I V E N
K V R B E A T J C D M O E U N S V A O D L O S I E L I S H
S E L S H W I L D L I F E W C A T F B Y R D T I V T L Q P
D I N Y B S P N H W R C T G L A D U S J A D O M A I N U Z
M O V A F J U G E S I R A P B H S Y R L I Q T R O K T V J
C C Z L Q E V G R A S S E S O L D E T E A W B K N O T Y X

H. Answers to Evaluation

1. c
2. b
3. d
4. a
5. d
6. a
7. Managed grasslands are areas managed for forage, pasture, or grassland habitat.
8. Grassland management involves managing the plants, animals, equipment, and practices needed for the successful use of grasslands.
9. Forages are primarily grasses and legumes grown for their soft vegetative parts, which are used as feed for livestock.
10. Climate, soil, plants, grazing, fire
11. Agriculturally, a grassland is an area managed to grow grass, legumes, or other pasture or range plants; they are mostly used for the production of forage.

UNIT I - GRASSLANDS AND GRASSLAND PLANTS

Name _____

Lesson 1: An Introduction to Grasslands

Date _____

EVALUATION

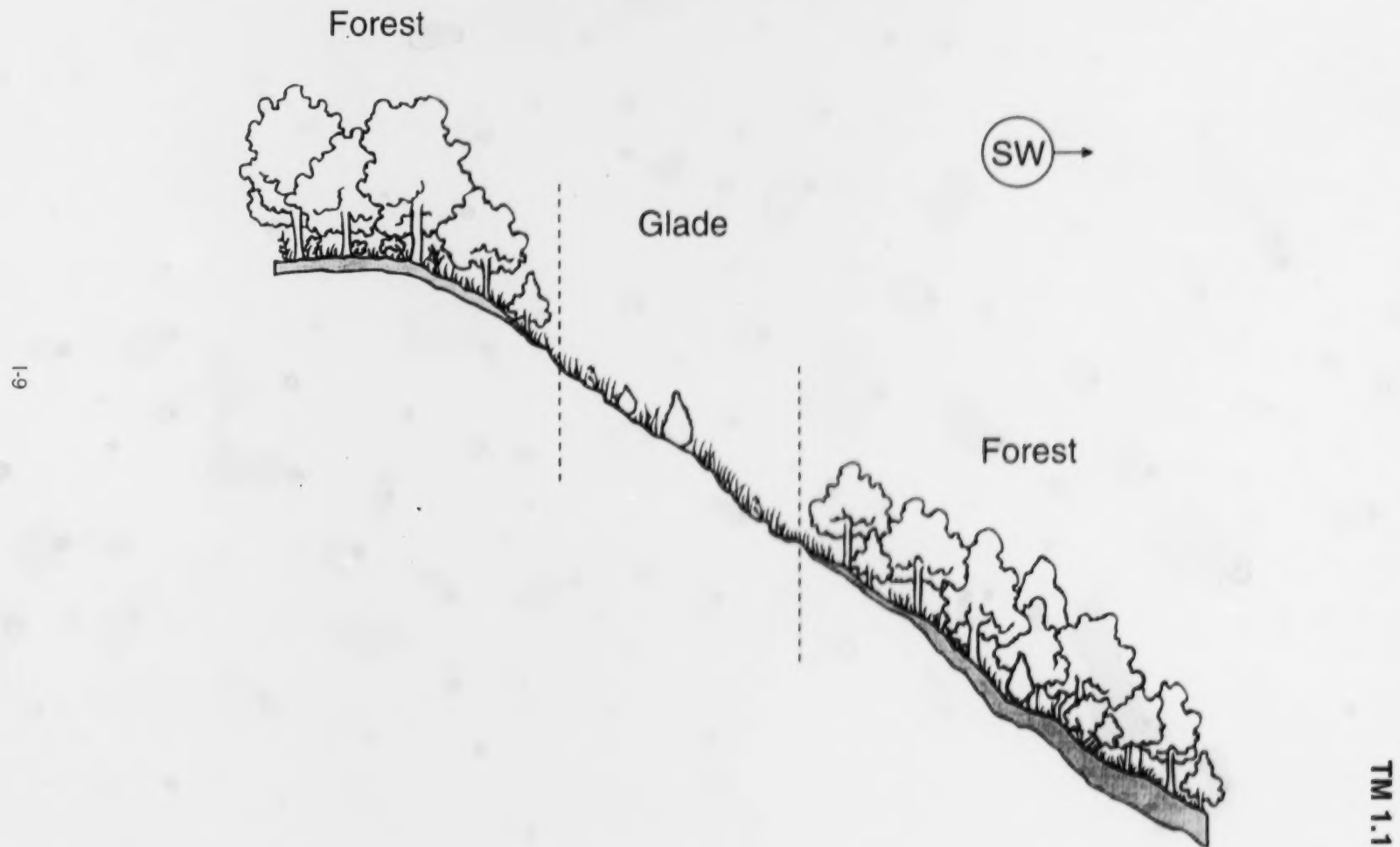
Circle the letter that corresponds to the best answer.

1. What is a savanna?
 - a. Small, isolated grasslands found on hilltops and southwest-facing slopes
 - b. Large grasslands in which trees and shrubs are nearly absent
 - c. Grasslands with widely spaced trees and grasses as the main ground cover
 - d. Grasslands in which plants and animals from western deserts are found
2. What is the goal of grassland conservation?
 - a. To preserve native grasslands undisturbed by humans
 - b. To insure their long-term productivity and sustainability
 - c. To conserve grasslands for uses other than agriculture
 - d. To make use of all remaining native grasslands
3. What is a prairie?
 - a. Grasslands in which many trees and shrubs are present
 - b. Small, isolated grasslands found on hilltops and southwest-facing slopes
 - c. Grasslands with desert-like conditions and desert plants and animals
 - d. Large grasslands in which trees and shrubs are nearly absent
4. Native grasslands:
 - a. Existed in America before the arrival of European settlers.
 - b. Include many different types of native European grasses.
 - c. Can be divided into two types--prairies and savannas.
 - d. Were seeded by Native Americans before Columbus arrived.
5. Missouri is at the transition point between grassland and forest because it receives ____ inches of rain a year.
 - a. 20
 - b. 25
 - c. 30
 - d. 35
6. What is a glade?
 - a. Small, isolated grasslands with desert-like conditions
 - b. Large grasslands in which trees and shrubs are nearly absent
 - c. Grasslands that consist of grassland with widely spaced trees
 - d. Grasslands in which many trees and shrubs are present

Complete the following short answer questions.

7. What are managed grasslands?
8. What does grassland management involve?
9. What are forages?
10. What are the five natural factors that affect the creation of grasslands?
 - a.
 - b.
 - c.
 - d.
 - e.
11. In agricultural terms, what is a grassland?

A Missouri Glade



Word Search

Objective: Identify terms associated with grasslands.

Using the clues provided, circle the terms connected with grasslands that are hidden in the puzzle. Words may be horizontal, vertical, or diagonal.

H H A B E C L I N T D N L L K B C R H A G J E P F I R A W
M A N T Q G R S A V C S S S E Z O A R K R T M O B O E A C
F A B D V N O R P L L O U A G G N D I N A O O P T I R K S
F O R I K S O N I B R Y S V A P M E L T S N W I L B M B L
E M O X T I A S I T Y M T E G L A D E I S O N R S J D Z S
Q G D N T A C L I V S A A G R A C R F S L D I N T B Y P H
B O A S O S T O N B L N I M A L S O S N A W M L O T E B M
M L I V B E O A T I N A N I Z Y H A Z C N C O R H A R S G
P L A K G U M O W I N G A N P E A R E K D O E G N M E O R
S P E N K W R L A N B E B G H R B G L S A N A N V R C K A
O H I C D V M S E R O M I L G N A T T I Y Z A O B O H M Z
C L O R I T I D I O N E L A S R H O P L I V E S T O C K I
A M P G A S S I N R X N I D O R P B R N A T V E S S G U N
P R A I R I E V P C O T T F T O N R B S J D Q E C H R L G
L A M O R K D E A I T Z Y S R D A O O U T A T B L I T E Y
A N T A O I N A T E O B O R T R S A K D X L A S I D Y G P
H A I L B T P A Y R V A F I P R U D V E U L K O M A B U R
I T M C A T V B P U B T I P O S S L E W D C K N A L X M O
J I H Q O R N D O T Q W R X A A C E V E G E T A T I V E N
K V R B E A T J C D M O E U N S V A O D L O S I E L I S H
S E L S H W I L D L I F E W C A T F B Y R D T I V T L Q P
D I N Y B S P N H W R C T G L A D U S J A D O M A I N U Z
M O V A F J U G E S I R A P B H S Y R L I Q T R O K T V J
C C Z L Q E V G R A S S E S O L D E T E A W B K N O T Y X

Clues:

1. Hardpan is a layer of _____ that discourages tree growth and so favors grasslands.
2. The term used to refer primarily to grasses and legumes used for their soft vegetative parts, which are eaten as feed.
3. The plants for which grasslands are named.
4. Large, continuous native grassland in which trees and shrubs are nearly absent.
5. Grassland _____ involves managing the plants, animals, equipment, and practices needed for the successful use of grasslands.
6. This is one use of grasslands; begins with a "P".
7. Forages are grown by producers as feed for _____.
8. The _____ of Missouri, which averages 35 inches of rainfall a year, places it at the transition point between grassland and forest.
9. An area managed to grow grasses, legumes, or other pasture or range plants for the production of forage.
10. Grassland plants tolerate this better than trees or shrubs; grasslands dominate where this occurs often enough to limit forest.
11. Grassland _____ is the wise use of grassland and other natural resources found on them.
12. _____ grasslands are those that existed in America before European settlers arrived.
13. Many _____ found on grasslands have adapted by becoming dormant when conditions are harsh.
14. Small, isolated native grassland occurring on a southwest-facing slope.
15. The soft _____ parts of forages--mainly the leaves and stems--are eaten.
16. Agricultural grasslands can be used for wildlife _____.
17. Before European settlement, grasslands adapted to _____ by buffalo, deer, and elk.
18. Grasses make up the bulk of plants in grasslands, but a rich diversity of _____ plants may also be present.
19. Forages consist primarily of grasses and _____.
20. One goal of grassland conservation; long-term _____.
21. Grasslands are harvested by grazing and mechanical _____.
22. Plants found on a grassland; the name starts with the letter "F".
23. Specialized community intermediate between grassland and forest.
24. Grasslands are used by animals, both livestock and _____.
25. The other goal of grassland conservation; starts with an "S".

UNIT I - GRASSLANDS AND GRASSLAND PLANTS

Lesson 2: Plant Classification

Competency/Objective: Identify plant classifications found in grasslands.

Study Questions

1. How can grassland plants be classified?
2. What are the characteristics of cool-season grasses?
3. What are the characteristics of warm-season grasses?
4. What are the characteristics of legumes?
5. What are the characteristics of forbs?
6. What are the characteristics of woody plants?
7. What plant species are found in grasslands?

References

1. *Introduction to Grassland Management (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1997, Unit I.
2. *Crop and Grassland Plant Identification Manual*. University of Missouri-Columbia: Instructional Materials Laboratory, 1997.
3. Transparency Masters
 - a) TM 2.1: Cool- and Warm-Season Grass Growth
 - b) TM 2.2: Grasses
 - c) TM 2.3: Legumes
 - d) TM 2.4: Forbs
 - e) TM 2.5: Woody Plants
4. Activity Sheets
 - a) AS 2.1: Constructing a Plant Press
 - b) AS 2.2: Identifying Grassland Plants

UNIT I - GRASSLANDS AND GRASSLAND PLANTS

Lesson 2: Plant Classification

TEACHING PROCEDURES

A. Review

As discussed in the last lesson, in agricultural terms, grasslands are any area of land that is managed to grow grasses, legumes, or other pasture or range plants. This lesson will look at the plants found in grasslands in greater detail. Grasses and legumes are the most beneficial plant species for forage production, while forbs and woody plants are more important for different wildlife populations. To be able to meet production goals and maintain wildlife populations, correct management practices must be adopted, based on the plant composition and production potential of the grassland.

B. Motivation

Have students bring in plant samples from grassland areas near their homes. Discuss what types of plants are found in grasslands and why grassland areas are important to agriculture.

C. Assignment

Have students create their own plant guide with samples collected from local grassland areas. The guides should include twenty different plants, with at least three from each classification. This project will be completed during Unit I. Since this lesson covers the different plant types found in a grassland, the plant samples should first be collected, mounted, and labeled according to their plant type (grass, legume, forb, or woody plant). The rest of the information should be completed after Lesson 3.

Materials:

Binder - to hold the plant guide together (ex. three-ring binder or photo album)

Adhesive - to mount the plant samples to the page (ex. glue, tape, or contact paper)

Paper - to hold samples and record information

NOTE: A template is provided in AS 2.2. It has a space for mounting the plant sample. The best way to mount plants is by placing clear contact paper over the entire sample.

D. Supervised Study

E. Discussion

1. Bring in several samples of grassland plants that represent the different types of foliage found in the local area. Include at least one grass, legume, forb, and woody plant. Have the class, as a whole or in groups, brainstorm on what makes these plants similar and different. Make sure that annuals, perennials, and (if possible) biennials are among the samples. Compose a list and discuss the results as they relate to plant types and life cycles.

NOTE: If live cuttings are not available, use detailed pictures of the different types of grassland plants from a reference, such as IML's *Crop and Grassland Plant Identification Manual*.

How can grassland plants be classified?

- a) Life cycle - classification system that identifies plants based on their yearly growth and seeding characteristics
 - 1) Annuals - complete life cycle occurs in one growing season

- 2) Biennials - complete life cycle occurs over two growing seasons
- 3) Perennials - grow year after year
- b) Plant type - classification system that identifies plant species and groups them according to their physical characteristics
 - 1) Grasses (cool- and warm-season)
 - 2) Legumes
 - 3) Forbs
 - 4) Woody plants
- 2. Separate the grasses from the other plant samples. Discuss how optimum temperature for growth divides them into cool-season or warm-season grasses, using TM 2.1 to illustrate the differences in their growing seasons. Point out some examples of cool-season grasses from the samples, such as Kentucky bluegrass, orchardgrass, and smooth brome grass. Discuss the characteristics of cool-season grasses. TM 2.2 can be used to illustrate the physical characteristics of grasses.

What are the characteristics of cool-season grasses?

- a) Herbaceous
- b) Hollow stems
- c) Blades and stems joined directly at sheath
- d) Parallel venation on leaf blade
- e) Grows when soil temperature reaches 40°F in early spring, with optimum growth occurring when air temperatures fall in the 59 to 77°F range in the spring and fall
- f) Dormant in summer
- g) Annuals or perennials
- 3. Point out some examples of warm-season grasses, such as Indiangrass, big bluestem, and switchgrass. Discuss the characteristics of warm-season grasses.

What are the characteristics of warm-season grasses?

- a) Herbaceous
- b) Hollow stems
- c) Blades and stems joined directly at sheath
- d) Parallel venation on leaf blade
- e) Grows when soil temperatures reach 60°F in spring, with optimum growth occurring when air temperatures fall in the 77 to 104°F range in summer
- f) Dormant in winter
- g) Annuals or perennials
- 4. Grasses are beneficial plants, but they are not the only ones. Because grasslands are made up of ranges and pasture, another plant type that is used for forage and is beneficial to the grassland is the legume. Point out some examples of legumes, such as clovers, alfalfa, and birdsfoot trefoil, and discuss the characteristics of legumes. TM 2.3 may also be used as an illustration.

What are the characteristics of legumes?

- a) One-chambered fruit with seeds in a single row within the pod
- b) Alternate leaf arrangement with leaves usually connected to petiole
- c) Network of veins
- d) Annuals, perennials, or biennials
- e) Nodules with nitrogen fixing capacity on most rooting systems

5. Other herbaceous plants that are neither grasses or legumes are forbs. Show examples of forbs, like sunflowers, thistles, and ragweed, from the grassland plant samples. Use TM 2.4 to further illustrate forbs. Discuss the characteristics of forbs with the class.

What are the characteristics of forbs?

- a) Herbaceous (not woody)
 - b) Broadleaf plants
 - c) Annuals, perennials, or biennials
6. The only nonherbaceous plant type found in grasslands is woody plants. In a grassland pasture or range, most woody plants will be weedy saplings or small immature trees and shrubs. Use TM 2.5 to illustrate woody plants. Show examples of woody plants from the grassland plant samples, such as wild rose, red cedar, and oak, and discuss their characteristics.

What are the characteristics of woody plants?

- a) Woody (nonherbaceous) stems
 - b) Shrubs, vines, or trees
 - c) Perennials
7. Ask students to list the various plant species found in grasslands with which they are familiar. Discuss different plant species found in grasslands.

NOTE: Have students refer to the *Crop and Grassland Plant Identification Manual* during the discussion of plant species.

What plant species are found in grasslands?

- a) Grasses and grasslike plants

Barley	<i>Hordeum vulgare</i>	Annual
Barnyardgrass	<i>Echinochloa crusgalli</i>	Annual
Bermudagrass	<i>Cynodon dactylon</i>	Perennial
Big bluestem	<i>Andropogon gerardi</i>	Perennial
Bromegrass	<i>Bromus inermis</i>	Perennial
Broomsedge	<i>Andropogon virginicus</i>	Perennial
Canada bluegrass	<i>Poa compressa</i>	Perennial
Caucasian bluestem	<i>Andropogon caucasicus</i>	Perennial
Cheat/Chess	<i>Bromus secalinus</i>	Annual
Corn	<i>Zea mays</i>	Annual
Crabgrass	<i>Digitaria sanguinalis</i>	Annual
Downy chess	<i>Bromus tectorum</i>	Annual
Fall panicum	<i>Panicum dichotomiflorum</i>	Annual
Giant foxtail	<i>Setaria faberi</i>	Annual
Goosegrass	<i>Eleusine indica</i>	Annual
Green foxtail	<i>Setaria viridis</i>	Annual
Indiangrass	<i>Sorghastrum nutans</i>	Perennial
Johnsongrass	<i>Sorghum halepense</i>	Perennial
Kentucky bluegrass	<i>Poa pratensis</i>	Perennial
Little bluestem	<i>Andropogon scoparius</i>	Perennial
Oats	<i>Avena sativa</i>	Annual
Orchardgrass	<i>Dactylis glomerata</i>	Perennial
Perennial ryegrass	<i>Lolium perenne</i>	Perennial
Prairie cupgrass	<i>Eriochloa contracta</i>	Annual
Purpletop	<i>Tridens flavus</i>	Perennial

Quackgrass	<i>Agropyron repens</i>	Perennial
Redtop	<i>Agrostis alba</i>	Perennial
Reed canarygrass	<i>Phalaris arundinacea</i>	Perennial
Rice	<i>Oryza sativa</i>	Annual
Rye	<i>Secale cereale</i>	Annual
Sandbur	<i>Cenchrus longispinus</i>	Annual
Smooth crabgrass	<i>Digitaria ischaemum</i>	Annual
Switchgrass	<i>Panicum virgatum</i>	Perennial
Tall fescue	<i>Festuca arundinacea</i>	Perennial
Three-awn grass	<i>Aristida oligantha</i>	Annual
Timothy	<i>Phleum pratense</i>	Perennial
Wheat	<i>Triticum aestivum</i>	Annual
Wirestem muhly	<i>Muhlenbergia frondosa</i>	Perennial
Witchgrass	<i>Panicum capillare</i>	Annual
Yellow foxtail	<i>Setaria glauca</i>	Annual
Yellow nutgrass or chufa	<i>Cyperus esculentus</i>	Perennial
b) Legumes		
Alfalfa	<i>Medicago sativa</i>	Perennial
Alsike clover	<i>Trifolium hybridum</i>	Perennial
Birdsfoot trefoil	<i>Lotus corniculatus</i>	Perennial
Black medic	<i>Medicago lupulina</i>	Annual
Common lespedeza or Japanese bush clover	<i>Kummerowia striata</i>	Annual
Common vetch	<i>Vicia sativa</i>	Annual
Crimson clover	<i>Trifolium incarnatum</i>	Annual
Crown vetch	<i>Coronilla varia</i>	Perennial
Hairy vetch	<i>Vicia villosa</i>	Annual/Biennial
Illinois bundleflower	<i>Desmanthus illinoensis</i>	Perennial
Korean lespedeza	<i>Kummerowia stipulacea</i>	Annual
Lead plant	<i>Amorpha canescens</i>	Perennial
Little hop clover	<i>Trifolium dubium</i>	Annual
Low hop clover	<i>Trifolium campestre</i>	Annual
Partridge pea	<i>Cassia fasciculata</i>	Annual
Red clover	<i>Trifolium pratense</i>	Biennial
Sericea lespedeza or silky bush clover	<i>Lespedeza cuneata</i>	Perennial
Slender lespedeza	<i>Lespedeza virginica</i>	Perennial
Soybean	<i>Glycine max</i>	Annual
Tick trefoil	<i>Desmodium spp.</i>	Perennial
White clover	<i>Trifolium repens</i>	Perennial
Yellow sweet clover	<i>Melilotus officinalis</i>	Biennial
c) Forbs		
Black nightshade	<i>Solanum americanum</i>	Annual
Bracted plantain	<i>Plantago aristata</i>	Annual
Buckwheat	<i>Fagopyrum esculentum</i>	Annual
Bull nettle	<i>Cnidioscolus texanus</i>	Perennial
Bull thistle	<i>Cirsium vulgare</i>	Biennial
Bur cucumber	<i>Sicyos angulatus</i>	Annual
Butterfly milkweed	<i>Asclepias tuberosa</i>	Perennial
Canada thistle	<i>Cirsium arvense</i>	Perennial
Cinquefoil	<i>Potentilla simplex</i>	Perennial
Common chickweed	<i>Stellaria media</i>	Annual

Common chicory	<i>Cichorium intybus</i>	Perennial
Common cocklebur	<i>Xanthium strumarium</i>	Annual
Common milkweed	<i>Asclepias syriaca</i>	Perennial
Common morning glory	<i>Ipomoea purpurea</i>	Annual
Common plantain	<i>Plantago major</i>	Annual
Common ragweed	<i>Ambrosia artemisiifolia</i> L.	Annual
Common sunflower	<i>Helianthus annuus</i>	Annual
Common yarrow	<i>Achillea millefolium</i>	Perennial
Corn cockle	<i>Agrostemma githago</i>	Annual
Cotton	<i>Gossypium hirsutum</i>	Annual
Croton	<i>Croton monanthogynus</i>	Annual
Daisy fleabane	<i>Erigeron strigosus</i>	Annual
Dandelion	<i>Taraxacum officinale</i>	Perennial
Field bindweed	<i>Convolvulus arvensis</i>	Perennial
Four-leaf milkweed	<i>Asclepias quadrifolia</i>	Perennial
Giant ragweed	<i>Ambrosia trifida</i> L.	Annual
Hedge bindweed	<i>Convolvulus sepium</i>	Annual
Hemp	<i>Cannabis sativa</i>	Annual
Henbit	<i>Lamium amplexicaule</i>	Perennial
Horse nettle	<i>Solanum carolinense</i>	Perennial
Ironweed	<i>Vernonia baldwini</i>	Perennial
Ivyleaf morning glory	<i>Ipomoea hederacea</i>	Annual
Jimsonweed	<i>Datura stramonium</i>	Annual
Kochia or burning bush	<i>Kochia scoparia</i>	Annual
Lamb's quarters	<i>Chenopodium album</i>	Annual
Lance-leaf ragweed	<i>Ambrosia bidentata</i>	Annual
Musk thistle	<i>Carduus nutans</i>	Biennial
Ox-eye daisy	<i>Chrysanthemum leucanthemum</i>	Perennial
Pale dock	<i>Rumex altissimus</i>	Perennial
Pennsylvania smartweed	<i>Polygonum pennsylvanicum</i>	Annual
Pepper grass	<i>Lepidium virginicum</i>	Annual
Pigweed	<i>Amaranthus spp.</i>	Annual
Prairie dogbane	<i>Apocynum cannabinum</i>	Perennial
Prairie goldenrod	<i>Solidago missouriensis</i>	Perennial
Prickly lettuce	<i>Lactuca serriola</i>	Biennial
Prickly sida	<i>Sida spinosa</i>	Annual
Queen Anne's lace or wild carrot	<i>Daucus carota</i>	Biennial
Sheep sorrel or field sorrel	<i>Rumex acetosella</i>	Perennial
Shepherd's purse	<i>Capsella bursa-pastoris</i>	Annual
Smartweed	<i>Polygonum lapathifolium</i>	Annual
Tabacco	<i>Nicotiana tabacum</i>	Annual
Tall thistle	<i>Cirsium altissimum</i>	Perennial
Three-seeded mercury	<i>Acalypha ostryaefolia</i>	Annual
Velvetleaf	<i>Abutilon theophrasti</i>	Annual
Venice mallow or flower of an hour	<i>Hibiscus trionum</i>	Perennial
Water hemp	<i>Amaranthus tamariscinus</i>	Annual
White avens	<i>Geum canadense</i>	Perennial
White mustard	<i>Brassica hirta</i>	Annual
Wild cucumber	<i>Echinocystis lobata</i>	Annual
Wild garlic	<i>Allium canadense</i>	Perennial
Wild strawberry	<i>Fragaria virginiana</i>	Perennial

d) Woody plants

Black cherry	<i>Prunus serotina</i>	Perennial
Black locust	<i>Robinia pseudoacacia</i>	Perennial
Black oak	<i>Quercus velutina</i>	Perennial
Black raspberry	<i>Rubus occidentalis</i>	Perennial
Coralberry or buckbrush	<i>Symphoricarpus orbiculatus</i>	Perennial
Dewberry	<i>Rubus flagellaris</i>	Perennial
Elm	<i>Ulmus spp.</i>	Perennial
Flowering dogwood	<i>Cornus florida</i>	Perennial
Grape	<i>Vitis spp.</i>	Perennial
Hawthorn	<i>Crataegus spp.</i>	Perennial
Hickory	<i>Carya spp.</i>	Perennial
High bush blackberry	<i>Rubus pensilvanicus</i>	Perennial
Honey locust	<i>Gleditsia triacanthos</i>	Perennial
Osage orange	<i>Maclura pomifera</i>	Perennial
Persimmon	<i>Diospyros virginiana</i>	Perennial
Poison ivy	<i>Rhus radicans</i>	Perennial
Redcedar	<i>Juniperus virginiana</i>	Perennial
Rose	<i>Rosa spp.</i>	Perennial
Sassafras	<i>Sassafras albidum</i>	Perennial
Smooth sumac	<i>Rhus glabra</i>	Perennial
White oak	<i>Quercus alba</i>	Perennial
Wild plum	<i>Prunus spp.</i>	Perennial
Willow oak	<i>Quercus phellos</i>	Perennial

F. Other Activities

Take a field trip to a nearby pasture or range and discuss the different types of plants found there. Have the students explain the different uses of the plants found for farmers, consumers, wildlife, hunters, landowners, and wildlife enthusiasts.

G. Conclusion

All plants in the grassland, whether cultivated or native, can be classified as grasses, legumes, forbs, or woody plants. The plants in each classification share characteristics that make the plants in that group similar. With an understanding of these plants and their importance, it is possible to reach reasonable forage crop production goals and satisfy the needs of a healthy wildlife population.

H. Answers to Evaluation

- | | |
|------|-------|
| 1. c | 6. e |
| 2. b | 7. f |
| 3. h | 8. g |
| 4. d | 9. b |
| 5. a | 10. c |

11. They are nonherbaceous, with woody stems.

12. The life cycle classification system identifies plants based on their yearly growth and seeding characteristics. The plant type classification system identifies plant species and groups them according to their physical characteristics.

UNIT I - GRASSLANDS AND GRASSLAND PLANTS

Name _____

Lesson 2: Plant Classification

Date _____

EVALUATION

Match the terms on the right with the best definition.

- | | |
|--|----------------------|
| _____ 1. Herbaceous, broadleaf plant with seeds in a single row within the pod | a. Cool-season grass |
| _____ 2. Plant that grows year after year | b. Perennial |
| _____ 3. Herbaceous, broadleaf plant growing in native habitat | c. Legume |
| _____ 4. Nonherbaceous perennial plant | d. Woody plant |
| _____ 5. Plant with parallel venation and optimum growth from 59 to 77°F | e. Biennial |
| _____ 6. Plant with a two-year life cycle | f. Warm-season grass |
| _____ 7. Plant with parallel venation and optimum growth from 77 to 104°F | g. Annual |
| _____ 8. Plant that completes its life cycle in one year | h. Forb |

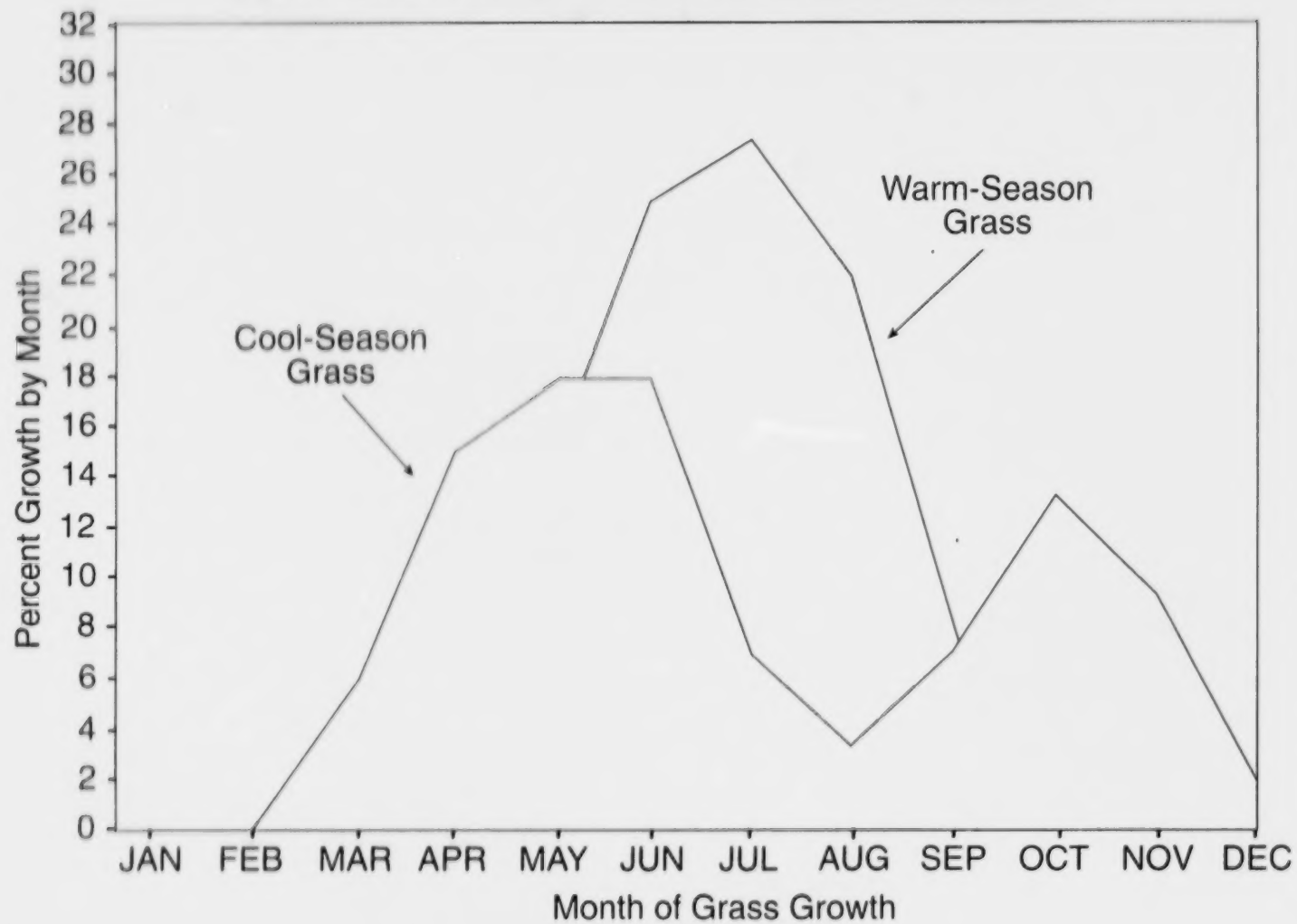
Circle the letter that corresponds to the best answer.

9. Which plant types are the dominant species in a grassland?
- a. All plant species
 - b. Grasses and legumes
 - c. Forbs and grasses
 - d. Woody plants, grasses, and legumes
10. Which plant type(s) will live for at least two years?
- a. Perennial only
 - b. Perennial and annual
 - c. Biennial and perennial
 - d. Biennial and annual

Complete the following short answer questions.

11. What makes woody plants different from all other plant types in a grassland?
12. In what two ways may grassland plants be classified? Explain each classification system.

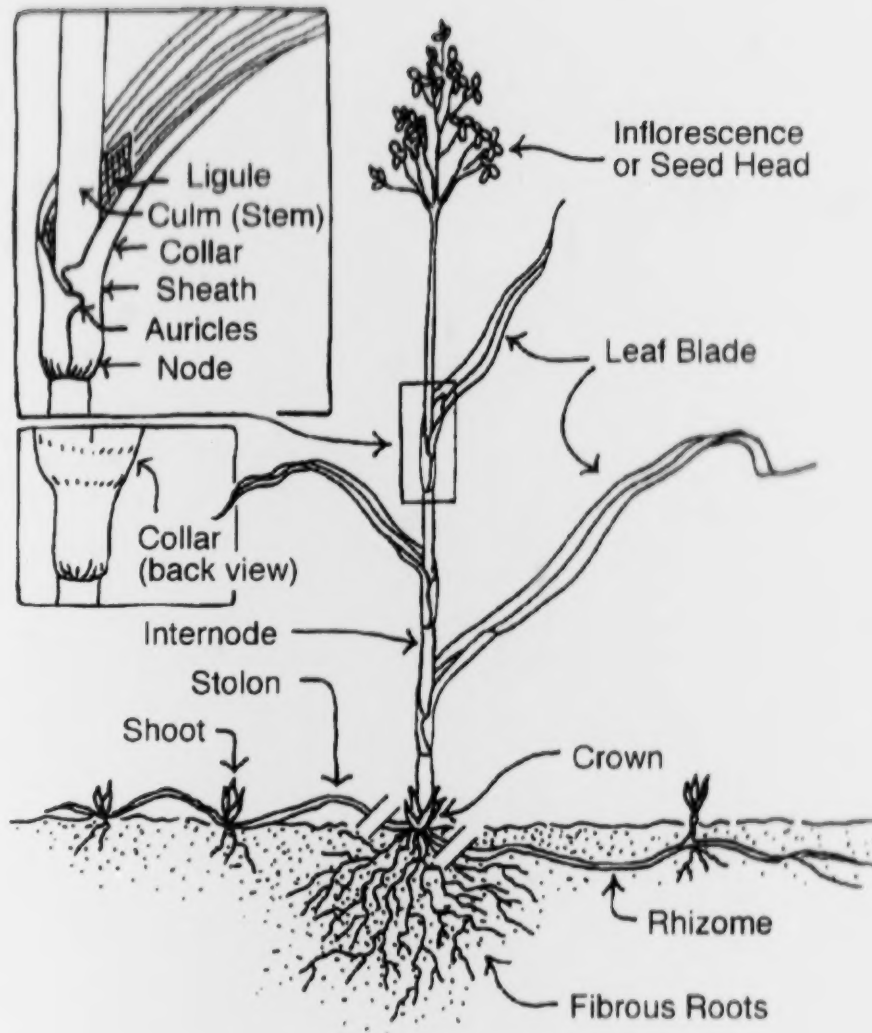
Cool- and Warm-Season Grass Growth



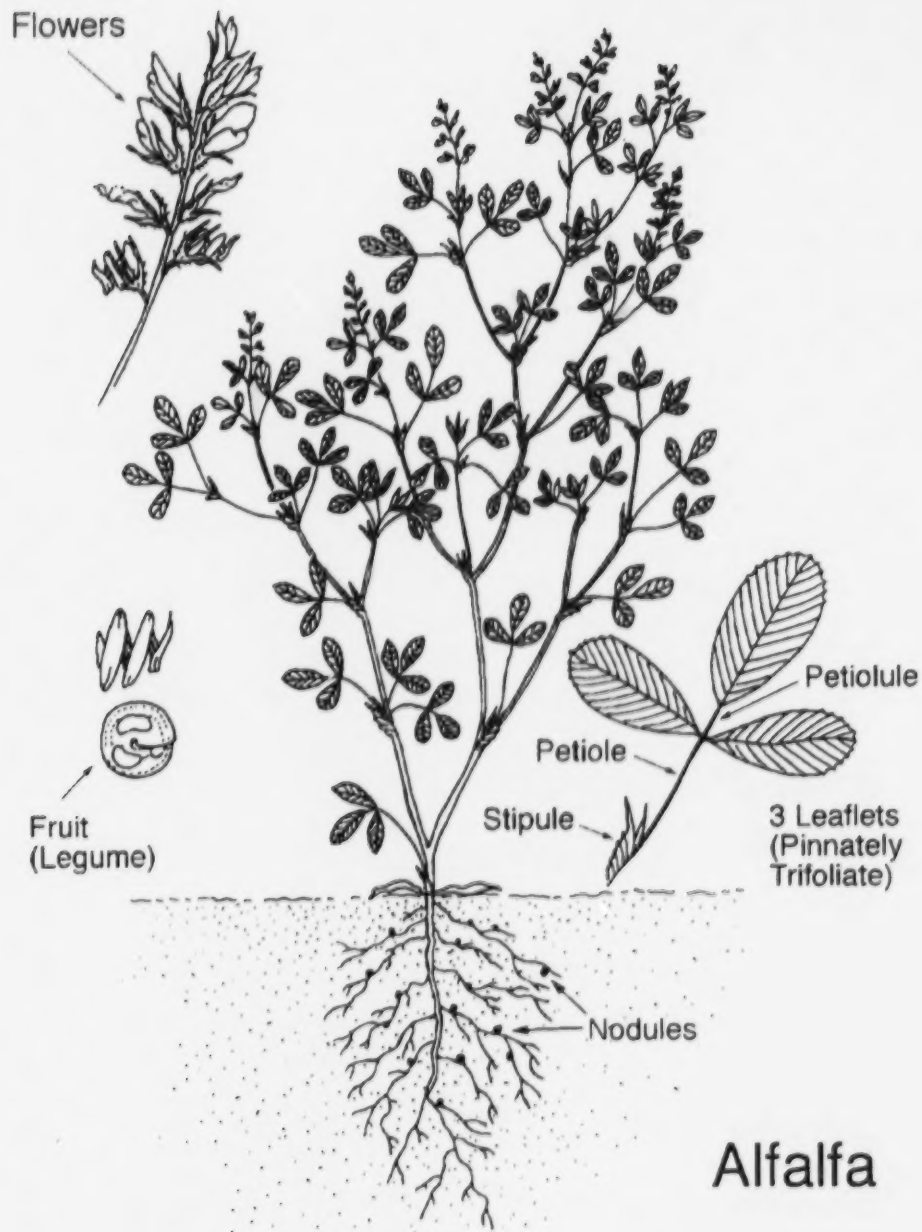
I-23

TM 2.1

Grasses



Legumes



Forbs

Flower

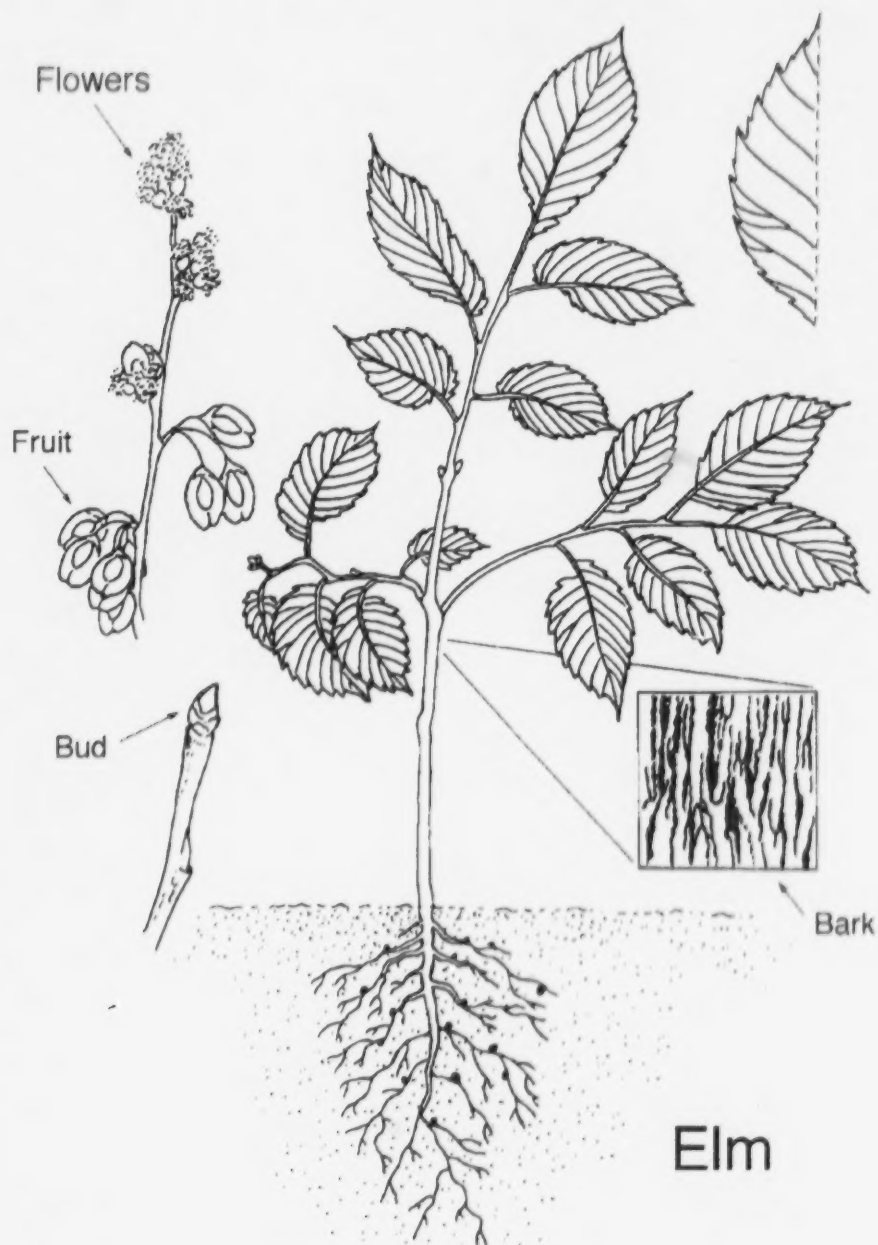


Fruit



Jimsonweed

Woody Plants



Elm

Constructing a Plant Press

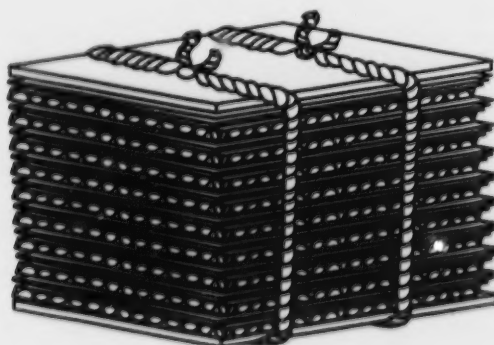
Objective: Build a plant press to use when collecting plant specimens for mounting.

Materials and Equipment:

2 plywood boards (16" x 12", ½" thick)
10 to 20 pieces of corrugated cardboard (16" x 12")
Newspaper
Rope

Procedure:

1. Alternate 8 to 10 pages of newspaper with the pieces of cardboard.
2. Put the stack between the boards.
3. Position the plants inside the folded newspaper, which acts as a blotter. More newspaper may be needed around juicy specimens. Special care should be taken when positioning the plants, since the appearance of the plants cannot be changed when they are dry because they become brittle and break easily.
4. Tie the rope tightly around the entire stack (see the illustration of a completed plant press below).
5. Set the press in a warm, dry area for several (four to five) days. If the stems and leaves are thick, the plants will take longer to dry. Remove the plants when they are dry.



Identifying Grassland Plants

Objective: Identify the classifications and characteristics of grassland plants.

Materials and Equipment:

Cutting utensils for collecting samples

Tape, glue, or contact paper

Three-ring binder or photo album

Procedure:

1. Collect twenty different plant species found in a grassland area. Include at least three plants from each plant type represented in the guide.
2. Press the plants using the plant press constructed in AS 2.1.
3. After the plants are pressed and dried, use tape, glue, or contact paper to attach these samples to the mounting sheets provided, one sample per page. Place the plants exactly as they should look, since they cannot be moved once they are attached.
4. Fill in the "Plant Type" section, identifying the plants as grasses, legumes, forbs, or woody plants. The rest of the sheet will be completed after Lesson 3.
5. Place the samples in the binder or photo album.

Date Found _____

Location _____

Botanical Name _____

Common Name(s) _____

Plant Type _____

Life Cycle _____

Root Structure _____

Modified Stem Structure _____

Inflorescence _____

Leaf

Grasses

Blade Shape _____

Collar _____

Leaf Bud Arrangement _____

Sheath _____

Auricle _____

Ligule Shape _____

Broadleaf Plants

Surface Texture _____

Arrangement _____

Venation _____

Type _____

Shape _____

Leaf _____

Base _____

Tip _____

Margin _____

General Comments:



UNIT I - GRASSLANDS AND GRASSLAND PLANTS

Lesson 3: Botanical Characteristics

Competency/Objective: Recognize the characteristics of grassland plants that are used in plant identification.

Study Questions

1. What are the structural parts of grasses?
2. How can leaf parts help identify grasses?
3. How can the root or modified stem be used to identify grassland plants?
4. How can the type of inflorescence help identify grassland plants?
5. What leaf structures and leaf arrangements are used in grassland plant identification?
6. How can stem shape be used to identify plants?
7. What are the external parts of the woody plant stem?

References

1. *Introduction to Grassland Management (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1997, Unit I.
2. *Crop and Grassland Plant Identification Manual*. University of Missouri-Columbia: Instructional Materials Laboratory, 1997.
3. Transparency Masters
 - a) TM 3.1: Identifying Characteristics of Grasses
 - b) TM 3.2: Roots and Modified Stems
 - c) TM 3.3: Inflorescence
 - d) TM 3.4: Leaf Structure and Arrangement
 - e) TM 3.5: Stem Structure of Woody Plants

UNIT I - GRASSLANDS AND GRASSLAND PLANTS

Lesson 3: Botanical Characteristics

TEACHING PROCEDURES

A. Review

In Lesson 2, plants were grouped by life cycle or plant type. Lesson 3 will show how to identify plants by looking at the differences in their structure. Plant parts that can be used for identification are roots, stem and blade parts, buds, and flowers.

B. Motivation

Have students observe the botanical characteristics of the samples collected in the last lesson. Notice the structural parts that make each sample different, such as leaf shapes, leaf arrangement, root structure, flowers, and buds. List the differences for each part on the chalkboard or overhead projector.

C. Assignment

Complete AS 2.2 from Lesson 2. The student's individual plant sheets should have the plant sample attached and the type of plant (forb, grass, legume, or woody plant) written in the blanks provided. The students should use the *Crop and Grassland Plant Identification Manual* and any other illustrated guides available to identify the plant and fill in the other sections of the guide page. This activity may be done individually or in groups. The teacher will need to show the students how to use the plant guide to identify the plants.

D. Supervised Study

E. Discussion

1. Ask students to name the different structural parts that may be used to identify grasses. Along with the schematic drawing provided in TM 2.1 from the previous lesson, display a grass sample so they can see the actual parts. Try to obtain a plant sample with roots and flowers.

What are the structural parts of grasses?

- a) Roots
 - b) Culm (stem)
 - c) Node
 - d) Internode
 - e) Leaf sheath
 - f) Leaf blade
 - g) Collar
 - h) Auricle
 - i) Ligule
 - j) Inflorescence (flowering part of the plant)
2. Ask students how the structural parts can help in identifying grasses. Discuss the differences in the leaf that can be observed to help distinguish one grass from another.

How can leaf parts help identify grasses?

- a) Leaf blade shape
 - 1) Tapering to tip

- 2) Boat-shaped tip
- 3) Parallel-sided
- 4) Narrowed to base
- b) Collar
 - 1) Broad
 - 2) Narrow
 - 3) Divided
 - 4) Oblique
 - 5) Hairy
 - 6) Hairy margins
- c) Leaf blade arrangement
 - 1) Folded
 - 2) Rolled
- d) Sheath
 - 1) Split
 - 2) Closed
 - 3) Split, margins overlapping
- e) Auricle
 - 1) Large
 - 2) Small
 - 3) Absent
- f) Ligule shapes
 - 1) Acuminate
 - 2) Acute
 - 3) Rounded
 - 4) Truncate
 - 5) Absent

3. Ask students to describe different types of root or modified stem structures they have seen on grassland plants, including trees, shrubs, grasses, forbs, and legumes. Discuss the basic structures found in grassland plants.

How can the root or modified stem structure be used to identify grassland plants?

- a) Roots
 - 1) Tap
 - 2) Fibrous
- b) Modified stems
 - 1) Rhizomes
 - 2) Stolons

4. Ask students to describe different arrangements of flowers they have seen on grassland plants. Display examples of typical grassland flowers for the students to observe. Discuss the six basic inflorescence structures found in grassland plants.

How does the type of inflorescence help identify grassland plants?

- a) Spike
- b) Raceme
- c) Panicle
- d) Terminal
- e) Axillary
- f) Umbel

5. Point out to students that the leaf on a legume, forb, or woody plant is just as important in identifying the plant as the leaf blade on a grass plant. Discuss the different parts and arrangements of leaves.

What leaf structures and leaf arrangements are used in grassland plant identification?

- a) Parts of a leaf
 - 1) Petiole
 - 2) Stipules
 - 3) Base
 - 4) Blade - surface texture
 - (a) Glabrous
 - (b) Pubescent
 - (c) Glaucous
 - b) Arrangement of leaves and buds
 - 1) Alternate
 - 2) Opposite
 - 3) Whorled
 - 4) Basal
 - c) Types of venation
 - 1) Parallel
 - 2) Netted
 - (a) Palmate
 - (b) Pinnate
 - d) Types of leaves
 - 1) Simple - May be lobed
 - 2) Compound
 - (a) Palmate
 - (b) Pinnate
 - (c) Bipinnate
 - (d) Trifoliate
 - e) Leaf anatomy
 - 1) Leaf shapes - ovate, obovate, oblong, oval, orbicular, linear, lanceolate, oblanceolate
 - 2) Margin shapes - entire, serrulate, serrate, doubly serrate, dentate, crenate, sinuate, undulate, lobed, incised
 - 3) Base shapes - truncate, cordate, rounded, cuneate
 - 4) Tip shapes - emarginate, obtuse, cuspidate, acute
6. Display cross sections of plants with different stem shapes. Discuss how stem shape can be used to identify plants.

How can stem shape be used to identify plants?

- a) Square
 - b) Round
 - c) Oval
 - d) Triangular
7. Ask students to identify the external parts of the woody plant stem.

What are the external parts of the woody plant stem?

- a) Buds
- b) Terminal bud
 - (a) Bud at the tip of the stem where new growth starts
 - (b) Usually the largest bud
 - (c) Can be flowering or vegetative

- 1) Axillary or lateral bud
 - (a) Bud found on the side of the stem
 - (b) Can be flowering or vegetative
- c) Nodes - joints from which leaves or branches grow
- d) Internodes - distance between two adjacent nodes
- e) Terminal bud scar - scar left from previous year's terminal bud
- f) Lenticels - breathing pores found scattered around stem
- g) Leaf scar - scar where leaf was attached to stem

F. Other Activities

1. Take a field trip to a grassland so that students can relate the drawings in this lesson to actual plants.
2. Supply students with examples of less common grassland plants and have them identify them based on their characteristics.

G. Conclusion

Plants can be identified by many characteristics. Grasses are usually identified in their vegetative state since they do not flower until late in the season. The structural parts of grasses are used to identify the plant. Each forb, legume, and woody plant is unique, with its own distinct stem structure, bud shape and size, leaf structure, leaf arrangement, and inflorescence. The types of plant species present determine the care a grassland needs.

H. Answers to Evaluation

1. c
2. b
3. a
4. a
5. d
6. c
7. a
8. d
9. b
10. b

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which of the following is not a type of leaf arrangement?
 - a. Alternate
 - b. Opposite
 - c. Parallel
 - d. Whorled
2. What is the name of the part of the grass plant that projects upward where the blade and sheath connect?
 - a. Apex
 - b. Ligule
 - c. Node
 - d. Sheath
3. The distance between which of the following shows one year's growth?
 - a. Bud scale scars
 - b. Leaf petiole scars
 - c. Lenticels
 - d. Nodes
4. Which of the following is part of a grass plant?
 - a. Collar
 - b. Lapel
 - c. Seam
 - d. Hem
5. Where does new growth start on woody plants?
 - a. Bud scale scar
 - b. Lenticels
 - c. Node
 - d. Terminal bud scar
6. Which of the following leaf types is pictured?
 - a. Palmate
 - b. Bipinnate
 - c. Trifoliate
 - d. Pinnate



7. What is the large bud at the end of a woody plant stem called?

- a. Terminal bud
- b. Axillary bud
- c. Lenticel bud
- d. Nodular bud

8. The arrow is pointing to what part of the leaf?

- a. Base
- b. Blade
- c. Midrib
- d. Petiole



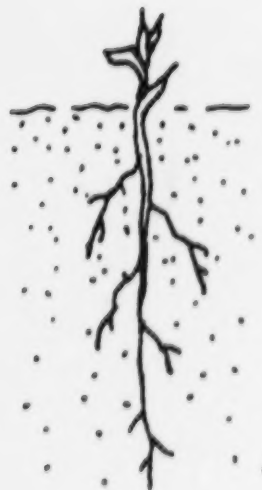
9. Which of the following inflorescence types is pictured?

- a. Spike
- b. Terminal
- c. Panicle
- d. Umbel



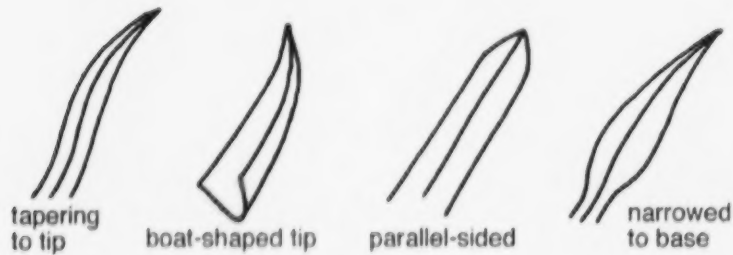
10. What is the name of the type of root system pictured?

- a. Fibrous
- b. Tap
- c. Stolons
- d. Rhizomes

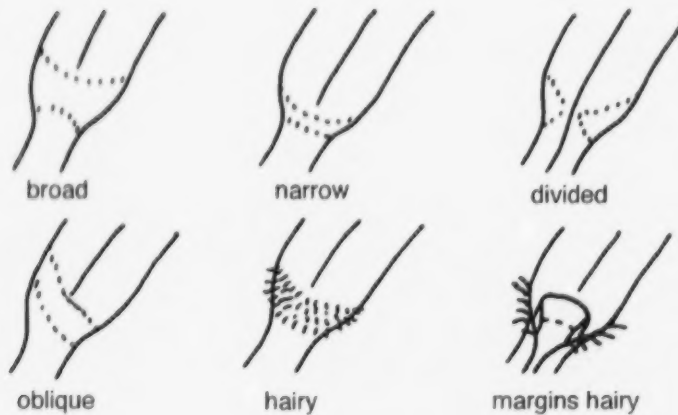


Identifying Characteristics of Grasses

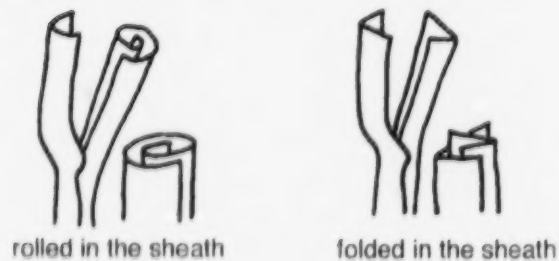
Leaf Blade Shapes



Collars



Leaf Blade Arrangements



Sheaths



split



split, margins overlapping



closed

Auricles



large



small



absent

Ligules



acuminate



acute



rounded



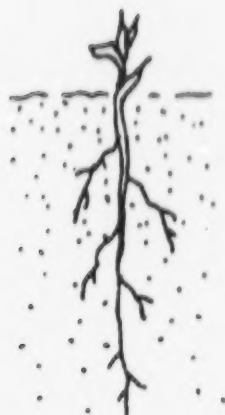
truncate



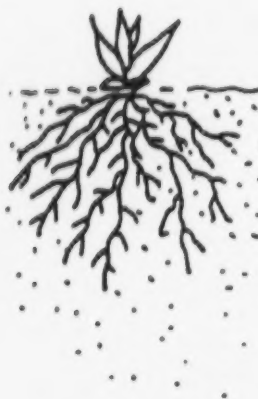
absent

Roots and Modified Stems

Root Structures

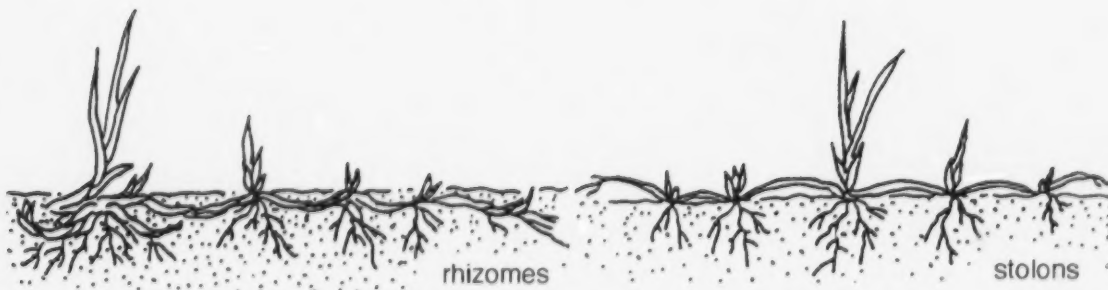


tap



fibrous

Modified Stems



rhizomes

stolons

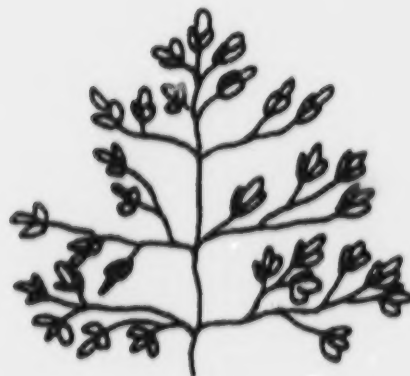
Inflorescence



spike



raceme



panicle



umbel



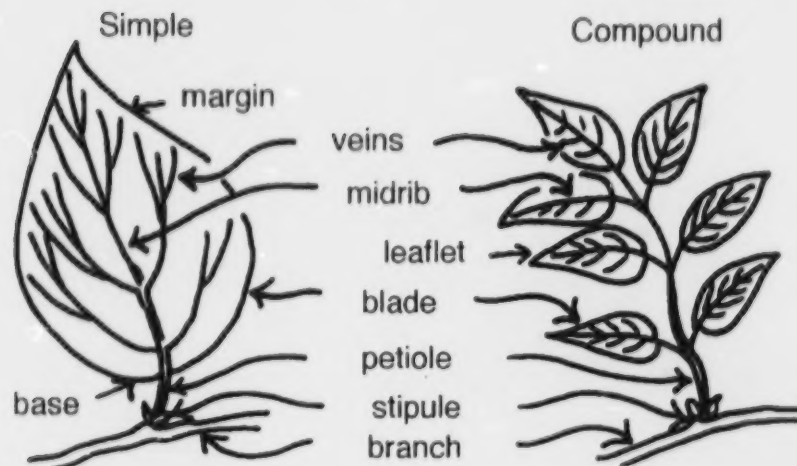
terminal



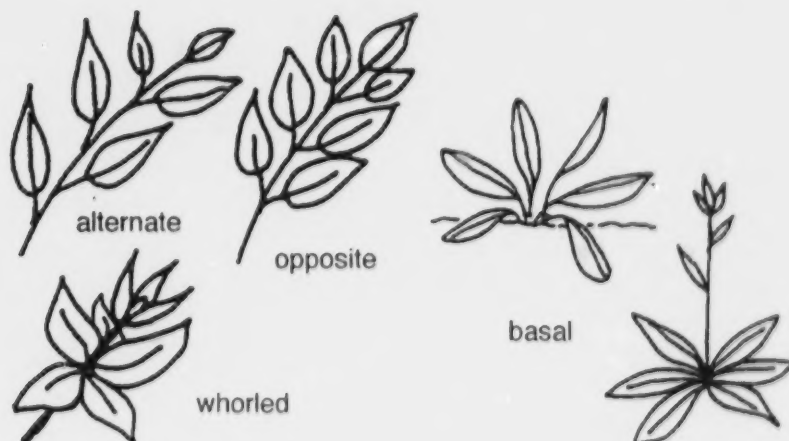
axillary

Leaf Structure and Arrangement

Leaf Parts



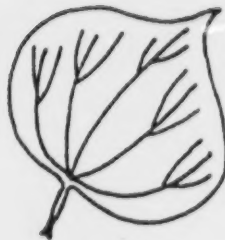
Leaf and Bud Arrangement



Leaf Venation



parallel



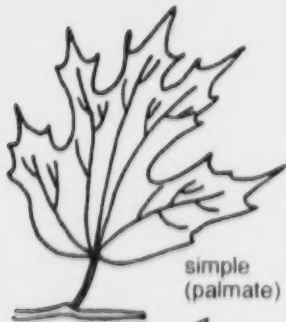
palmate



pinnate

Leaf Types

Simple

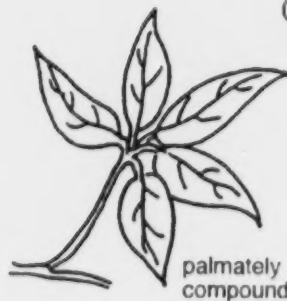


simple
(palmate)

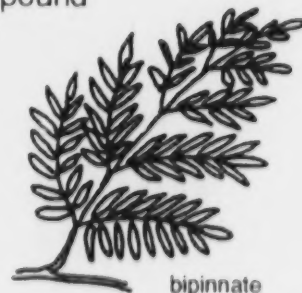


simple
(pinnate)

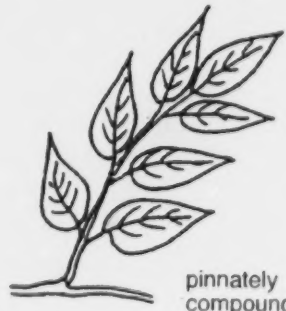
Compound



palmately
compound



bipinnate



pinnately
compound



trifoliate

Leaf Shapes



ovate



obovate



oblong



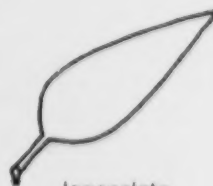
oval



orbicular



linear



lanceolate



oblanceolate

Common Leaf Margins

entire



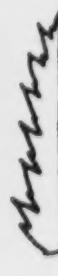
serrulate



serrate



doubly serrate



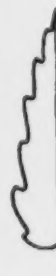
dentate



crenate



sinuate



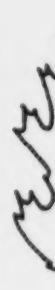
undulate



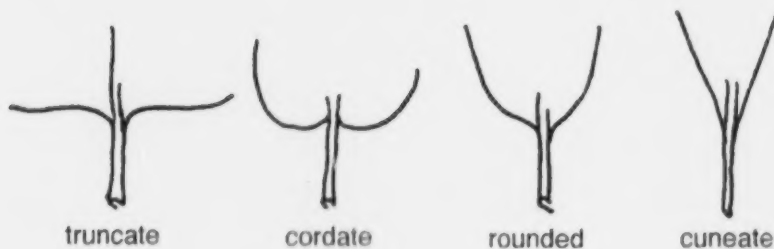
lobed



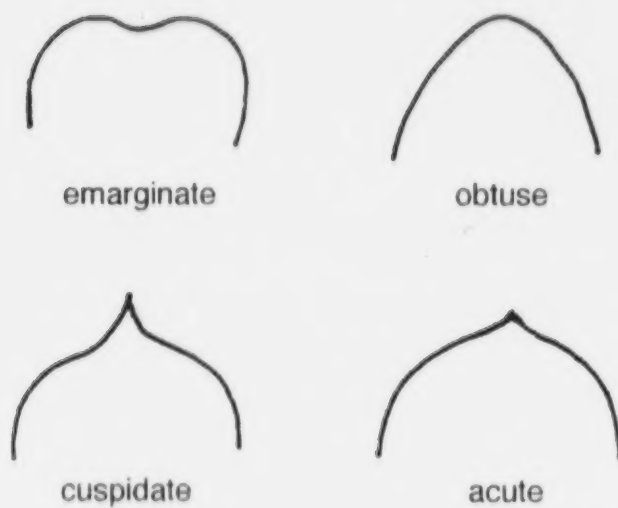
incised



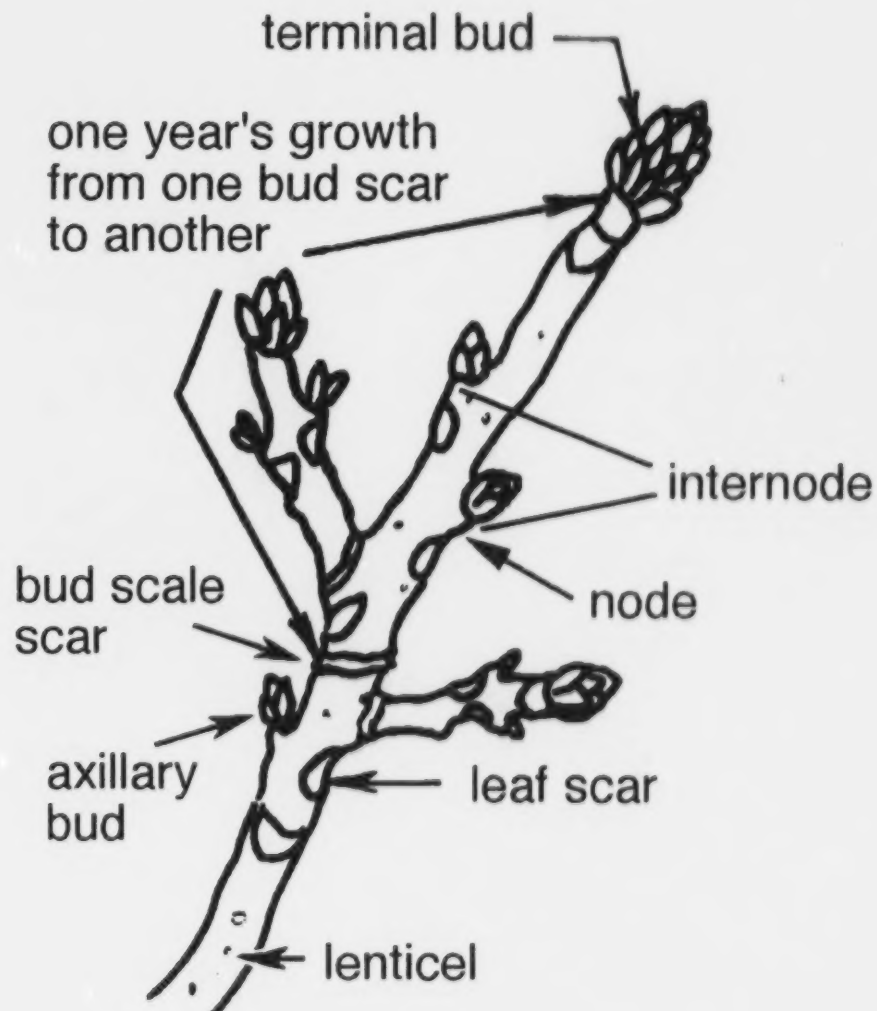
Common Base Shapes



Common Tip Shapes



Stem Structure of Woody Plants



UNIT I - GRASSLANDS AND GRASSLAND PLANTS

Lesson 4: Grassland Composition

Competency/Objective: Appraise the current conditions of the grassland.

Study Questions

1. Why is it important to determine grassland composition?
2. How is grassland composition determined?
3. What makes a grassland viable for livestock and wildlife?
4. What factors affect forage quality?

References

1. *Introduction to Grassland Management (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1997, Unit I.
2. Activity Sheet
 - a) AS 4.1: Grassland Composition Survey (Instructor)
 - b) AS 4.1: Grassland Composition Survey (Student)

UNIT I - GRASSLANDS AND GRASSLAND PLANTS

Lesson 4: Grassland Composition

TEACHING PROCEDURES

A. Review

In Lesson 3, the various plant identification characteristics were discussed. This lesson will explore grassland composition--the types, numbers, and quality of plants found in the grassland. The emphasis will be on pastures for livestock.

B. Motivation

Take a field trip to a nearby grassland area, preferably one used for livestock. Identify the factors that make the area good or bad for its current use. Discuss how all of these factors work together to make the grassland viable.

C. Assignment

D. Supervised Study

E. Discussion

1. The quality of a grassland depends on the types of plants it contains. For example, a grassland with a lot of weeds and woody plant saplings would not be of as high quality as one with a mixture of cool-season grasses and legumes. Discuss the importance of determining grassland composition.

Why is it important to determine grassland composition?

- a) Livestock
 - 1) Helps when estimating production potential
 - 2) Used to determine the length of the grazing season
 - 3) Used to adjust plant composition to reach optimum economic yields
 - b) Wildlife
 - 1) Helps when estimating its potential for wildlife management
 - 2) Used to adjust plant composition to achieve successful wildlife management
2. Ask students how they would determine the composition of a grassland. Have students complete AS 4.1.

How is grassland composition determined?

- a) Visual appraisal of a given area of land
 - b) By appraising the grassland using a stick to determine the percentages of different plants in the grassland
3. Ask students if they think the basic needs of all animals are the same. Once they realize that animal needs are similar, list some of those needs on the board. Discuss with students the factors that make a grassland viable for both livestock and wildlife.

What makes a grassland viable for livestock and wildlife?

- a) Food
 - 1) Livestock - need quality forages, including native warm-season grasses, cool-season grasses, and legumes
 - 2) Wildlife - need a greater mixture of plants, since different animals may feed on leaves, stems, twigs, bark, roots, fruits, seeds, or insects or small mammals supported by these plants
 - b) Shelter
 - 1) Livestock - use terrain and large plants like trees to reduce the effects of sun, heat, wind, and cold
 - 2) Wildlife - use brush piles, nearby woods, and tall grasslike plants for nesting and protection from predators
 - c) Water
 - 1) Livestock - require a surface source of water, such as a freeze-proof water tank located below a pond or at a water hydrant
 - 2) Wildlife - can drink from streams or ponds or obtain moisture from berries, plants, or dew, depending on the species
4. Forage quality affects livestock feeding on the forage, the hay or silage produced from it, and the wildlife living off the land. Forage quality refers to the nutritive value of the forage needed to produce a desired level of animal performance. Ask students to list factors that affect forage quality.

What factors determine forage quality?

- a) Laboratory analysis
 - 1) Moisture - water present in the forage
 - 2) Crude protein (CP) - includes both true protein and nonprotein nitrogen; indicates the ability of the forage to meet an animal's requirements for protein
 - 3) Acid detergent fiber (ADF) - percentage of indigestible plant material; as ADF increases, digestibility and energy decrease
 - 4) Neutral detergent fiber (NDF) - percentage of structural or cell wall material; low NDF correlates to increased feed intake
 - 5) Total digestible nutrients (TDN) - percentage of digestible material; higher ADF corresponds to lower TDN
 - 6) Net energy for lactation (NE_l) - measurement indicating the energy available in a forage to meet the requirements of lactating cows
 - 7) Net energy for maintenance (NE_m) - measurement indicating the energy available in a forage to meet the requirements for maintenance in meat-producing livestock
 - 8) Net energy for gain (NE_g) - measurement indicating the amount of energy available in a forage to produce growth or gain
- b) Field assessment
 - 1) Stage of growth - Nutritive value decreases as plants mature because the plants have more indigestible material due to higher fiber content.
 - 2) Type of forage - Plant species differ in digestibility and energy content.
 - 3) Growing conditions - Quality is affected by the environment, including the temperature, amount of sunlight, and amount of rainfall.
 - 4) Presence of noxious weeds - Weeds affect intake because they are less palatable; are also less nutritious.

G. Conclusion

Grassland composition refers to the quality and variety of plants that grow in the grassland; it can be determined by making an appraisal of the land. A knowledge of grassland composition can be used to benefit both livestock and wildlife. A viable grassland should include quality food, shelter, and water. Forage quality depends on many factors, with stage of growth being the most important.

H. Answers to Activity Sheets

AS 4.1

Answers will vary.

I. Answers to Evaluation

1. b
2. d
3. Quality food, shelter, water
4. Answers may include any four of the following: moisture, crude protein, acid detergent fiber, neutral detergent fiber, total digestible nutrients, net energy for lactation, net energy for maintenance, or net energy for gain.
5. A producer can determine grassland composition by making a visual appraisal of a given area of land or by using a stick to determine the percentages of different plants in the grassland.

UNIT I - GRASSLANDS AND GRASSLAND PLANTS

Name _____

Lesson 4: Grassland Composition

Date _____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Which factor causes forage quality to fluctuate within the same plant as it matures?
 - a. Net energy for gestation
 - b. Stage of growth
 - c. Type of growth
 - d. Crude protein
2. Which is not an important reason to determine grassland composition?
 - a. Helps to estimate the production potential for livestock
 - b. Used to adjust the plant composition for optimum economic yields
 - c. Shows the length of grazing season based on seasonal growth
 - d. Indicates the quality of the forage available in the grassland

Complete the following short answer questions.

3. What are the three factors necessary to create a viable grassland for livestock and wildlife?
 - a. _____
 - b. _____
 - c. _____
4. What are four items that are examined when forage quality is scientifically analyzed?
 - a. _____
 - b. _____
 - c. _____
 - d. _____
5. How can a producer determine grassland composition?

Lesson 4: Grassland Composition

Grassland Composition Survey

Objectives: Determine the approximate plant composition of a grassland.

Materials and Equipment:

Two plots (50' x 50') of grassland

Pencil and paper

IML's *Crop and Grassland Plant Identification Manual*

Stick with pointed tip (for Procedure 2)

Procedure:

1. Identify two different plots of land that students can use to conduct a composition survey. If possible, the two plots should have different plant compositions for purposes of comparison.
2. Have half of the class do one plot and the other half do the other plot.

Procedure 1:

3. Demonstrate how to find the percentages of different plants in the grassland. Show students how to walk slowly in one direction for 50 steps. With each step, they should record names of the plants in front of their toes and keep a running tally of their number.
4. After the students have approximated the plant composition for their plot, have them answer key questions 1 and 2 on AS 4.1. Have students share these answers with the class.
5. In a class discussion, come up with an average for the plant compositions for each plot.
6. Have students answer key questions 3 and 4.

Procedure 2:

3. Explain to the students how to use a stick to find the percentages of different plants in the grassland. Have them take ten steps in a random direction in the plot. They should then place the stick on the ground on end. Whatever plant the tip lands on should be recorded, and the total number of each of the plants the stick touches should be tallied in a systematic way. At least ten to twenty determinations should be made.
4. After the students have approximated the plant composition for their plot, have them answer key questions 1 and 2 on AS 4.1. Have students share these answers with the class.
5. In a class discussion, come up with an average for the plant compositions for each plot.
6. Have students answer key questions 3 and 4.

Grassland Composition Survey

Objectives: Determine the approximate plant composition of a grassland.

Materials and Equipment:

Two plots (50' x 50') of grassland

Pencil and paper

IML's *Crop and Grassland Plant Identification Manual*

Procedure:

Note: Half the class will work on one plot and the rest on the other plot.

1. Your instructor will explain the method for finding the percentages of different plants in the grassland. Record the names of the plants and keep a running tally of the total number of each kind of plant.
2. Record the totals for each plant.
3. Add the totals to calculate the entire number of plants recorded.
4. For each plant, divide the total for that plant by the total number of plants. Multiply by 100 to find the approximate percentage of that plant in the grassland.

Key Questions:

1. What is the primary plant type in your plot?
2. What are some uses for the grassland that these plants could support?
3. How does the other plot of land differ in plant composition from the one you evaluated?
4. How, if at all, do these differences affect the best use of the land?

UNIT II - SOIL MANAGEMENT

Lesson 1: Soil Tests

Competency/Objective: Interpret soil test information.

Study Questions

1. What information is included on a soil test report?
2. How does the interpretation of the current soil analysis affect the nutrient requirements for a selected cropping option?
3. How is the probability of yield response to fertilizer application determined?
4. How is the amount of lime needed per acre determined?

References

1. *Introduction to Grassland Management (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1997, Unit II.
2. *Soil Science*. University of Missouri-Columbia: Instructional Materials Laboratory, 1995.
3. University Extension agricultural publications
 - a) G9102: *Liming Missouri Soils*
 - b) G9110: *How to Get a Good Soil Sample*
 - c) G9111: *Using Your Soil Test Results*
 - d) G9112: *Interpreting Missouri Soil Test Reports*
4. Activity Sheets
 - a) AS 1.1: Word Search
 - b) AS 1.2: Taking a Soil Sample

UNIT II - SOIL MANAGEMENT

Lesson 1: Soil Tests

TEACHING PROCEDURES

A. Introduction

Soil characteristics are important in grassland management. With the information provided by a soil test, a producer can improve the productivity of the soil. Small improvements in the soil can make a big difference in achieving production goals.

B. Motivation

Demonstrate how to take a soil sample. If possible, show students soil test results for samples taken earlier from the same area. Have students take soil samples using AS 1.2.

C. Assignment

D. Supervised Study

E. Discussion

1. Ask students if they have ever seen a soil test report. Discuss the information included on a soil test report.

What information is included on a soil test report?

- a) Field information - contains information provided by the producer to identify the field and summarize previous management
 - b) Soil test information
 - 1) Provides the results of the soil tests performed on the sample
 - 2) Provides the necessary data to develop nitrogen, phosphate, potash, and agricultural lime recommendations for the intended cropping option
 - c) Rating - provides a rating for the salt pH and nutrients tested
 - d) Nutrient requirements - contains three parts: cropping options, yield goal, and fertilizer recommendations
 - e) Cropping options - lists cropping plans or crops for which fertilizer recommendations were requested
 - f) Yield goal - shows the level of production selected for the crops listed in the cropping options section
 - g) Pounds per acre
 - 1) Lists the fertilizer recommendations for the crops and yield goals listed in pounds of N (nitrogen), P_2O_5 (phosphate), and K_2O (potash)
 - 2) Designed to provide an agronomic recommendation of the nutrients needed to meet the yield goal and improve soil fertility over time
 - h) Limestone suggestions
 - 1) Gives the suggested amount of limestone to raise soil salt pH to an optimal level for the cropping options listed
 - 2) Given for the cropping option requiring the highest salt pH range
 - 3) Reported as pounds of effective neutralizing material (ENM) per acre
 - i) Special notes - helps the producer interpret and use the results and recommendations
2. Understanding how to interpret the results of the soil analysis will help students to comprehend why treatments are needed to improve the soil. Ask students why it is important to provide the soil test

laboratory with different cropping options. Point out that the treatments provided are crop specific for the best growth, optimum yields, and lowest economic cost.

How does the interpretation of the current soil analysis affect the nutrient requirements for a selected cropping option?

- a) Basic soil test results
 - 1) pH_s (salt pH)
 - (a) Indicates the relative level of soil acidity
 - (b) Improves root development and provides a good environment for soil microorganisms
 - 2) Phosphorus (P)
 - (a) Measured in terms of its relative availability for plant growth, not the total amount in the soil
 - (b) Range from very low to very high
 - 3) Potassium (K)
 - (a) Measured by the amount available for plant growth and not by the amount in the soil
 - (b) Used with the cation exchange capacity (CEC) to determine the additional amount of potassium needed
 - 4) Calcium (Ca)
 - (a) Used to calculate CEC
 - (b) Based on the soil pH
 - 5) Magnesium (Mg)
 - (a) Only added if levels are very low to medium
 - (b) Can be applied with lime in dolomitic limestone, which contains calcium and magnesium
 - 6) Organic matter (O.M.)
 - (a) Refers to the decayed plant material, or humus, in the soil
 - (b) Used in estimating the potential nitrogen available to a crop during the growing season
 - 7) Neutralizable acidity
 - (a) Measures exchangeable hydrogen
 - (b) Aids in calculating liming requirements for the soil
 - 8) Cation exchange capacity (CEC) - measures the ability of the soil to hold positively charged nutrients called cations (calcium, magnesium, potassium, and hydrogen)
 - b) Routine fertilizer recommendations
 - 1) Nitrogen (N) - determined by cropping option, soil texture, and organic matter
 - 2) Phosphorus and potassium - added to the fertilizer mix based upon the soil test and the desired yield of a particular crop
3. Have students explain how ratings on the soil report relate to the probable yield response caused by fertilizer application.

How is the probability of yield response to fertilizer application determined?

- a) The soil test rating provides information on the probability that the application of a particular fertilizer will increase crop yield.
 - b) The probability of an increase in yields from fertilizer drops as the soil test rating rises.
4. Ask students if they have ever helped lime a field. If they have, ask them how the tons of lime needed per acre was determined. Have students complete AS 1.1.

How is the amount of lime needed per acre determined?

Calculate the amount of lime required per acre by dividing the effective neutralizing material (ENM) value from the soil test by the ENM of the limestone. ENM indicates the ability to reduce soil acidity.

$$\frac{\text{ENM required by the soil test}}{\text{ENM of agricultural limestone}} = \text{tons of limestone/acre}$$

F. Other Activities

Take a soil sample from a school-owned planting area. Use the results to determine what amendments would provide increased yields or improve plant growth in that area. This activity would be most beneficial as an ongoing project, so students could see how the soil has changed from year to year. If this is to be done, be sure to keep the soil test reports and the treatments for each year.

G. Conclusion

Soil tests are helpful in reaching production yield goals. They report the current status of the soil and provide suggestions to improve the soil and increase crop yields.

H. Answers to Activity Sheets

AS 1.1

H E L P Q R C I C M A G N E S I U M O R D R F Y S I D L T
 A C I D I T Y I P I D Z O K O G N F Q K Z F R T V N R H Y
 M O M O A F T M R C P D O L O M I T I C Q X N T R E H Z I
 R S E O M E D V H R O N Q P N O D Y E N V E D H H U E A E
 P T A P M F F K V O A I F E O F R Z I Q I F T Y Q T M H L
 R H P E R W H W I O I T E D I J H N J R R E P D P R V L D
 R P O R O S E T F R A R Y W R F L C T N P P R R P A I Y E
 S Q M S O I L I T G A O O L J B I U J J L T Z O G L S A N
 T O M O P I V U U A N G F E N R N G A G R A N G M I O L T
 Z Y P N F H H A K N Q E O J Z O B J E J N W D E Q Z N P S
 I X Q R A F O T Y I Y N A D R C S A M P L E C N M A M N N
 Z I N C U V D R V S O C T C M J W M H J L N F U N B E B J
 A C L A O B Q B U M F V I Q O R G A N I C U E N M L N L M
 B H A C F A L Y B S Z M O M F A Z T D S A M R S P E T P J
 D Z D G K D S H K A F G N P B C G S E J Q U T E S Y J Z Y
 V E M C B N C P O T A S S I U M G R H I L X I P N P U R B
 N U E Q O F E A S O L F U R Q G U B E X R Z L E J X O A L
 A H A I O Z C X B B U M N C G T J X J U L U I L L T P O R
 M D T A F H F A D M B C X U X C A G D S Z A T Q A W T M D
 B A A K R B Y Z L E F A M E F B G C S I Z M Y R E T I S L
 C D U B M D H A U C Y D T B H X B R G K L J O T A O O O D
 U A R A T I N G C B I B N P G D Y B K A U B Z L X B N M Q
 A B M D A F M B K D X U B X B I G Y G R A C M L S Y S W L
 B F E R T I L I Z E R K M Y R C J C J L T P A T A Z T O C

I. Answers to Evaluation

1. b
2. d
3. a
4. a
5. d
6. 1.9 tons/acre
7. The soil test rating provides information on the probability that the application of a particular fertilizer will increase crop yield. The probability of an increase in yields from fertilizer drops as the soil test rating rises.
8. The data can be used to develop recommendations for nitrogen, phosphate, potash, and agricultural lime.

UNIT II - SOIL MANAGEMENT

Name _____

Lesson 1: Soil Tests

Date _____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Fertilizer recommendations for which of the following are given on the soil test report under "Pounds per acre"?
 - a. N_3
 - b. P_2O_5
 - c. KO
 - d. N_2O
2. Which of the following does not affect the amount of nitrogen needed for the soil?
 - a. Cropping option
 - b. Soil texture
 - c. Organic matter
 - d. Neutralizable acidity
3. What does the salt pH of the soil indicate?
 - a. Acidity of the soil
 - b. Amount of phosphorus
 - c. Ability to hold nutrients called cations
 - d. Nitrogen content of the soil
4. What information is found in the yield goal section of the soil test report?
 - a. Level of production selected for the crops
 - b. Fertilizer recommendations for yield goals
 - c. Previous yields from that field
 - d. Current levels of soil nutrients
5. Dolomitic limestone can be used to add _____ to the soil.
 - a. Phosphorus
 - b. Potassium
 - c. Nitrogen
 - d. Magnesium

Complete the following short answer questions.

6. How many tons of limestone should be applied per acre if the ENM from the soil test is 950 and the ENM of the limestone is 500?

7. How can a soil test report be used to determine the probability of yield response to the application of fertilizer?

8. How is the data that is provided in the soil test information section of the report used?

Word Search

Objective: Identify vocabulary associated with soil tests.

Using the clues provided, circle the terms connected with soil tests that are hidden in the puzzle. Words may be horizontal, vertical, or diagonal.

H E L P Q R C I C M A G N E S I U M O R D R F Y S I D L T
A C I D I T Y I P I D Z O K O G N F Q K Z F R T V N R H Y
M O M O A F T M R C P D O L O M I T I C Q X N T R E H Z I
R S E O M E D V H R O N Q P N O D Y E N V E D H H U E A E
P T A P M F F K V O A I F E O F R Z I Q I F T Y Q T M H L
R H P E R W H W I O I T E D I J H N J R R E P D P R V L D
R P O R O S E T F R A R Y W R F L C T N P P R R P A I Y E
S Q M S O I L I T G A O O L J B I U J J L T Z O G L S A N
T O M O P I V U U A N G F E N R N G A G R A N G M I O L T
Z Y P N F H H A K N Q E O J Z O B J E J N W D E Q Z N P S
I X Q R A F O T Y I Y N A D R C S A M P L E C N M A M N N
Z I N C U V D R V S O C T C M J W M H J L N F U N B E B J
A C L A O B Q B U M F V I Q O R G A N I C U E N M L N L M
B H A C F A L Y B S Z M O M F A Z T D S A M R S P E T P J
D Z D G K D S H K A F G N P B C G S E J Q U T E S Y J Z Y
V E M C B N C P O T A S S I U M G R H I L X I P N P U R B
N U E Q O F E A S O L F U R Q G U B E X R Z L E J X O A L
A H A I O Z C X B B U M N C G T J X J U L U I L L T P O R
M D T A F H F A D M B C X U X C A G D S Z A T Q A W T M D
B A A K R B Y Z L E F A M E F B G C S I Z M Y R E T I S L
C D U B M D H A U C Y D T B H X B R G K L J O T A O O O D
U A R A T I N G C B I B N P G D Y B K A U B Z L X B N M Q
A B M D A F M B K D X U B X B I G Y G R A C M L S Y S W L
B F E R T I L I Z E R K M Y R C J C J L T P A T A Z T O C

Clues:

1. Effective neutralizing material is used to calculate the amount of _____ needed.
2. Positively charged nutrients; calcium, magnesium, potassium, hydrogen.
3. _____ acidity
4. Abbreviation for effective neutralizing material
5. _____ limestone may be applied when both lime and magnesium are needed.
6. Zinc, manganese, iron, and copper
7. The way the soil _____ is taken may influence the results of the test.
8. Proper pH levels provide a good environment for soil _____.
9. K
10. Decayed plant material; _____ matter
11. The amount of nitrogen added is determined in part by the soil _____.
12. The fertilizer recommendation is designed to provide recommendations for the nutrients needed to meet yield goals and improve soil _____ over time.
13. pH indicates the _____ of the soil.
14. Zn
15. A section under Nutrient Requirements; cropping _____
16. Phosphorus and potassium are added in the _____ mix.
17. _____ tests
18. P
19. The rating for _____ levels is based on the soil pH.
20. Dolomitic limestone contains calcium and _____.
21. Neutralizable acidity measures the exchangeable _____.
22. N
23. Samples are sent to a _____ for testing.
24. The soil test _____ indicates the relative level of each nutrient tested.
25. _____ goal

Taking a Soil Sample

Objective: Take a soil sample.

Materials and Equipment:

Soil probe, soil auger, or spade
Clean plastic bucket

Procedure:

1. Scrape away any surface mat of grass or litter.
2. Using a soil probe, soil auger, or spade, take fifteen to twenty separate samples in a random zigzag pattern across a relatively uniform area. The sample should not represent more than twenty acres. Each sample should contain six to seven inches of soil.
3. Place each sample in the bucket.
4. Mix the soil samples well to make a composite sample.
5. If samples are wet, the composite must be air-dried before it can be submitted for testing. One pint should be kept for analysis.

UNIT II - SOIL MANAGEMENT

Lesson 2: Using Soil Survey Manuals

Competency/Objective: Interpret soil survey manuals and recommend plants for a soil type.

Study Questions

1. What parts of the soil survey manual apply to grassland management?
2. How is property located in a soil survey manual?
3. How are the uses of the soil type determined?
4. What are the possible soil classifications?
5. What soil factors affect plant selection?
6. What are the common drainage classifications?
7. Where can a soil survey manual/map be obtained?

References

1. *Introduction to Grassland Management (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1997, Unit II.
2. Local soil survey manual or map
3. Transparency Master
 - a) TM 2.1: Forage Adaptation by Soil Drainage Class

UNIT II - SOIL MANAGEMENT

Lesson 2: Using Soil Survey Manuals

TEACHING PROCEDURES

A. Review

Lesson 1 addressed soil test reports. This lesson will discuss soil survey manuals produced by soil scientists. Few people realize the valuable information available to everyone in the manuals. Maps, chemical and physical properties of soils, and information for agricultural, engineering, recreational, and urban uses are all supplied in the manual. In this lesson, aspects of soil survey manuals, especially as they pertain to grassland management, will be discussed. It will also examine the effect of soils on plant selection. Plants are dependent on the soil for their life and productivity. Therefore, when selecting plants, the soil's capacity to contribute to the yield of the crop is of extreme importance.

B. Motivation

1. Bring in copies of local soil survey manuals. Allow the students to attempt to locate their home and read the information concerning the soils found in that area. Discuss the various ways that this information might be useful.
2. Show students aerial photographs and a soil survey map to illustrate the different scales and buildings and landmarks.
3. Have a specialist in soil science come and discuss the procedure for compiling the soil survey manuals with the class.
4. Write the analogy "Soil is to plants as water is to fish" on the board. Discuss what the relationship might be between them. A few similarities are that plants and fish depend on either soil or water for survival, that some water and types of soil are not suitable for fish or plant growth, and that all nutrients and food needed for fish or plants can be supplied through water or soil.

C. Assignment

D. Supervised Study

E. Discussion

1. Ask students what soil information not provided on the soil test report they would need to know if they were managing a grassland area. Use the answers as a bridge into the list provided below.

What parts of the soil survey manual apply to grassland management?

- a) How to use the soil survey - provides an introduction to or review of the survey; includes the general soils map for land use planning
- b) Soil maps - aerial photographs on which phases of soil series are drawn to be used in making land use decisions
- c) Use and management of the soils - descriptions of land use potential and management for all areas of interest
- d) Descriptions of the soils - series by series soil description with information on characteristics, limitations on use, land capability, and suggested management practices
- e) Formation and classification of the soil - information on uniform systems of soil classification

2. Discuss the maps provided in the manual. Ask students why they might be included. Using the local manual, show the location of the school as an example of the procedure for locating specific plots of land. Have students refer to the instructions in the front of the soil survey manual.

How is property located in a soil survey manual?

- a) Use the "Index to Map Sheets" to locate the property.
 - b) Go to the page number of the map sheet indicated by the index.
 - c) Locate the property on the map using landmarks and features and/or the U.S. standard land survey system.
3. The soil scientist interprets all the information for a particular area and determines the uses of that soil. Ask students how this determination is made.

How are the uses of the soil type determined?

- a) Permanent limitations - cannot be easily changed; includes severe slope, soil depth, flooding, and large rocks
 - b) Temporary limitations - can be removed or improved; includes soil nutrient content, moderate slope, and minor drainage problems
4. Some soils are more useful than others. For example, a plot of land on a rocky mountain is not going to be nearly as productive as a river bottom plot with a deep topsoil layer. Therefore, soils are classified according to the permanent limitations and hazards that affect the productivity of the soil. Have students describe the classification system and soil classifications.

What are the possible soil classifications?

- a) Cultivable
 - 1) Class I (1) - very few limitations
 - 2) Class II (2) - has a few limitations that reduce plant choices or require moderate conservation practices
 - 3) Class III (3) - requires special conservation practices with extra effort and costs because of severe limitations that reduce plant choices
 - 4) Class IV (4) - requires very careful management and/or special conservation practices because of very severe limitations
 - b) Noncultivable
 - 1) Class V (5) - suitable for pasture and wildlife; limitations are difficult to remove and prevent the use of standard farm equipment
 - 2) Class VI (6) - used for grassland, range, or wildlife due to severe limitations
 - 3) Class VII (7) - very severe limitations
 - 4) Class VIII (8) - mountainous areas
 - c) E, W, S - Additional labels for Classes II through VIII, standing for erosion (E), wet (W), and stoniness, shallowness, or droughtiness (S)
5. Many aspects of the soil affect plant growth. These are therefore important to consider when selecting plants for the grassland. Have students list factors that influence plant selection.

What soil factors affect plant selection?

- a) Soil texture - relative proportions of sand, silt, and clay particles in soil; affects the amount of contact plant roots have with available water, air, and nutrients
- b) Soil depth - area that plant roots have available to extend downward; limits the type of plants that can root in the soil
- c) Slope - steepness of the land's surface; affects erosion and ability to use farm machinery
- d) Erosion - loss of soil by wind or water; decreases soil depth by removing topsoil

- e) Surface runoff - rate at which water disappears from the soil surface by absorption or flowing over the soil; leads to erosion, leaching of soil nutrients, and washing away of seeds or nutrients
 - f) Permeability - movement of air and water through the soil; affects root penetration, water movement in and on the soil, and nutrient leaching
 - g) Drainage - speed at which the water moves from the soil's surface; affects plant growth through a lack of or an excessive amount of water
6. Water movement in and above the soil also affects the productivity of a grassland. Ask students how soils are distinguished by drainage classifications. Use TM 2.1 to show plant adaptation by soil drainage classes.

What are the common drainage classifications?

- a) Excessively drained soils - very porous and freely permeable
 - b) Somewhat excessively drained soils - free movement of water and air, but less than excessively drained soils
 - c) Well-drained soils - sandy or intermediately textured; uniform color with mottling near deep water table
 - d) Moderately well-drained soils - slower internal water movement and more mottling further up the profile; artificial drainage needed for alfalfa
 - e) Somewhat poorly drained soils - surface wet for many weeks; mottling just below surface; artificial drainage usually needed
 - f) Poorly drained soils - surface wet for many months; mottling throughout profile; artificial drainage required
 - g) Very poorly drained soils - wet almost every month; usually gray with mottling on surface; artificial drainage difficult to install but required
7. County soil survey manuals are free to all Missouri residents. A fee is charged to all non-Missouri residents. Ask students where they can be obtained.

Where can a soil survey manual/map be obtained?

- a) Soil and Water Conservation districts
- b) Natural Resources Conservation Service offices

F. Other Activities

- 1. Have the students locate their homes in the soil survey manual. Using the information in the manual, the students should write a report on what they think is the best use of the land and why. Ask them to defend the answers with soil facts from the manual.
- 2. Use the soil survey manuals to simulate exercises. They should allow the students to practice map reading and interpretation of the information provided in the manual. Ask for information pertinent to grassland management. Land uses and crop selection should be derived by the students. Factual information provided by the manual may also be incorporated into the activity. The extent of this activity is dependent on the objectives of the teacher.

G. Conclusion

Soil survey manuals contain a lot of material that is useful to the grassland manager. However, the manual is only useful if the user has an understanding of the organization of the manual and a basic knowledge of soils. Soil type and drainage affect the productivity of plants and should therefore be considered when selecting plants for the grassland.

H. Answers to Evaluation

1. b
2. a
3. b
4. g
5. f
6. d
7. e
8. c
9. a
10. Use the "Index to Map Sheets" to locate the property. Go to the page number of the map sheet indicated by the index. Locate the property on the map using landmarks and features and/or the U.S. standard land survey system.
11. Permanent limitations cannot be easily changed, while temporary limitations can be removed or improved. Examples of permanent limitations include severe slope, soil depth, flooding, and large rocks. Examples of temporary limitations include soil nutrient content, moderate slope, and minor drainage problems.
12. b
13. h
14. e
15. d
16. a
17. g
18. c
19. f
20. Decreases soil depth and removes topsoil
21. Affects root penetration, water movement, and nutrient leaching
22. Affects the amount of contact roots have with water, air, and nutrients

UNIT II - SOIL MANAGEMENT

Name _____

Lesson 2: Using Soil Survey Manuals

Date _____

EVALUATION

Circle the letter that corresponds to the best answer.

1. Where can soil survey manuals be obtained?
 - a. Local U.S. post office
 - b. Soil and Water Conservation district
 - c. Farm Credit Service
 - d. U.S. Soil Evaluation Center
2. Soil maps for more detailed land use planning show the land using what type of pictures?
 - a. Aerial
 - b. Panoramic
 - c. Color
 - d. Topographic

Correctly match the appropriate drainage class with the description of that class.

- | | |
|--|---------------------------------|
| _____ 3. Very porous; freely permeable for great depths | a. Well drained |
| _____ 4. Wet for many months of the year; mottling prominent throughout the profile; artificial drainage required for crop growth | b. Excessively drained |
| _____ 5. Slower internal water movement; more mottling further up the profile; artificial drainage suggested for alfalfa crop | c. Somewhat poorly drained |
| _____ 6. Wet almost every month of the year; usually gray in color with mottling on the surface; artificial drainage may be difficult to install but is required for crop growth | d. Very poorly drained |
| _____ 7. Water and air move freely, but slower than other soils | e. Somewhat excessively drained |
| _____ 8. Surface is wet for many weeks throughout the year; mottling is prominent just below the surface; artificial drainage usually needed | f. Moderately well drained |
| _____ 9. Most often sandy or intermediately textured soils; color is uniform except near the deep water table, where it becomes mottled | g. Poorly drained |

Complete the following short answer questions.

10. What are the steps in locating property in a soil survey manual?
11. What is the difference between the permanent and temporary limitations used in determining a soil's uses? Give an example of each.

Match the soil classification on the right with its description on the left.

- | | |
|--|---------|
| _____ 12. Requires moderate conservation practices | a. I |
| _____ 13. Mountainous areas | b. II |
| _____ 14. Prevents use of standard farm equipment due to limitations | c. III |
| _____ 15. Requires very careful management and/or special conservation practices | d. IV |
| _____ 16. Very few limitations | e. V |
| _____ 17. Very severe limitations | f. VI |
| _____ 18. Requires special conservation practices with extra costs and effort | g. VII |
| _____ 19. Used for grassland, range, or wildlife due to severe limitations | h. VIII |

List potential problems affecting plant growth for each of these factors.

20. Erosion -

21. Permeability -

22. Soil texture -

Forage Adaptation by Soil Drainage Class

	Very Poorly Drained	Poorly Drained	Somewhat Poorly Drained	Moderately Well Drained	Well Drained	Somewhat Excessively Drained	Excessively Drained
Alfalfa				X	X	X	
Annual Lespedeza				X	X	X	X
Birdsfoot Trefoil			X	X	X	X	
Red Clover			X	X	X	X	
White or Ladino Clover			X	X	X		
Bromegrass			X	X	X		
Big Bluestem			X	X	X	X	
Tall Fescue		X	X	X	X	X	X
Indiangrass			X	X	X	X	X
Orchardgrass				X	X	X	
Switchgrass		X	X	X	X	X	X
Timothy			X	X	X	X	
Caucasian Bluestem				X	X	X	X
Bermudagrass			X	X	X	X	X
Little Bluestem				X	X	X	X
Kentucky Bluegrass			X	X	X	X	X
Reed Canarygrass	X	X	X	X	X	X	

*Adaptation of a particular forage may vary from this chart depending on other soil characteristics.

UNIT III - GRASSLAND MANAGEMENT PRACTICES

Lesson 1: Grasslands and the Nutritional Needs of Livestock

Competency/Objective: Analyze the nutrient needs of livestock.

Study Questions

1. **What determines the nutritional needs of livestock?**
2. **What is the daily forage dry matter intake requirement for cattle?**
3. **When does the livestock herd have the highest forage quality requirement?**
4. **How is daily dry matter intake calculated?**

References

1. *Introduction to Grassland Management (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1997, Unit III.
2. Transparency Master
 - a) TM 1.1: Energy Needs of a Mature Beef Cow for Spring Calving
3. Activity Sheet
 - a) AS 1.1: Calculating Dry Matter Intake

UNIT III - GRASSLAND MANAGEMENT PRACTICES

Lesson 1: Grasslands and the Nutritional Needs of Livestock

TEACHING PROCEDURES

A. Introduction

Unit 3 will examine grassland management. The unit begins by looking at management practices for livestock production. The focus is on beef production, since Missouri ranks second behind Texas in total beef cattle produced. This lesson will discuss the need to choose the appropriate amount and quality of forage to meet the nutritional needs of livestock. Different classes of cattle require various amounts of forage and levels of forage quality. The grassland manager must learn how to calculate the daily dry matter intake requirement in order to ensure that the cattle receive enough nutrients.

B. Motivation

Discuss with students how grass quality affects cattle gains, allowing for quicker sales and higher profits. In addition, point out that people who show and judge cattle appreciate the smoother appearance and better overall composition of the animals due to quality forage.

C. Assignment

D. Supervised Study

E. Discussion

1. Just as the nutritional needs of humans differ according to their growth and life stage, so do the nutritional needs of livestock. Ask students to describe what determines the nutritional needs of livestock.

What determines the nutritional needs of livestock?

- a) Type of production (function)
 - 1) Maintenance - carbohydrates, fats, protein, and minerals
 - 2) Growth - protein, carbohydrates, fats, minerals, and vitamin D
 - 3) Fattening - carbohydrates and fats
 - 4) Reproduction - protein, carbohydrates, fats, and minerals
 - 5) Rebreeding - carbohydrates, fats, protein, and vitamins
 - 6) Lactation - carbohydrates, fats, protein, and minerals
 - 7) Work - carbohydrates and fats
 - b) Level of output or production
 - c) Size of the animal
2. Ask students if they know the daily forage dry matter intake requirements for cattle. Emphasize that factors such as size and level of production affect the amount of forage required for production. Point out that dry matter intake is given as a percentage of live bodyweight.

What is the daily forage dry matter intake requirement for cattle?

- a) Dry beef cow - 2% of bodyweight
- b) Lactating beef cow (average milk prod.) - 2.5% of bodyweight
- c) Lactating beef cow (superior milk prod.) - 3% of bodyweight
- d) Bull (during breeding season) - 2.5% of bodyweight

- e) Bull (out of breeding season) - 2% of bodyweight
 - f) Growing steers and heifers - 3% of bodyweight
3. Ask students when the herd needs the highest quality forage. Use TM 1.1 to illustrate the changing energy needs of a mature beef cow.

When does the livestock herd have the highest forage quality requirement?

- a) The herd has the highest forage requirement after the majority of the cows have given birth, when they require energy for lactation and rebreeding (Stage 1).
 - b) In spring calving, cows calve just before the peak of grass growth in May and June, when forage quality is very high.
 - c) Fall calving matches the period of highest nutritional needs with another peak in grass growth in October.
4. Have students explain how daily dry matter intake is calculated. Point out that optimum production requires close management and supervision. The calculation of daily dry matter intake will help to produce the best livestock possible. Have students complete AS 1.1.

How is daily dry matter intake calculated?

- a)
$$\text{Daily dry matter intake} = \frac{\text{\# of animals in a class}}{\text{in a class}} \times \frac{\text{avg. weight per animal}}{\text{per animal}} \times \frac{\text{forage dry matter intake requirement}}{\text{intake requirement}}$$
- b) The number of pounds of forage dry matter needed per day for a herd is equal to the total of the daily dry matter intake for all classes of cattle in the herd.

F. Other Activities

Visit the facilities of a local dairy or beef cattle operation. Have the manager describe the procedures used for feeding the cattle and the changes made based on growth, gestation, lactation, and maintenance.

G. Conclusion

The true test of a productive grassland is the livestock it produces. If the grassland meets the nutritional needs of the animals during all of their life stages, it is successful. In order to meet these needs, the grassland manager must match the production potential of the grasses to them. The best grasslands will provide nutrients in a sufficient quantity to allow the producer to meet his or her production goals for the herd.

H. Answers to Activity Sheet

AS 1.1

- 1. 2,136.5 lbs.
- 2. 1,010 lbs.
- 3. 3,964 lbs.

I. Answers to Evaluation

1. d
2. d
3. b
4. The herd has the highest forage requirement after the majority of the cows have given birth. In spring calving, cows calve just before the peak of grass growth when forage quality is very high. Fall calving matches the period of highest nutritional needs with another peak in grass growth.
5. Any four of the following: maintenance, growth, fattening, reproduction, rebreeding, milk production, and work
6. 1,615 lbs. of dry forage matter per day

UNIT III - GRASSLAND MANAGEMENT PRACTICES

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Lesson 1: Grasslands and the Nutritional Needs of Livestock

Date _____

EVALUATION

Circle the letter that corresponds to the best answer.

1. What factor does not affect the nutritional needs of livestock?
 - a. Production function
 - b. Size of the animal
 - c. Level of output
 - d. Breed of the animal
2. Which animal has the highest forage quantity requirements?
 - a. Bull, during breeding season
 - b. Bull, out of breeding season
 - c. Mature, unbred dry cow
 - d. Mature, high-lactating cow
3. During breeding season, a bull has a daily forage dry matter intake requirement of how much of his body weight?
 - a. 2%
 - b. 2.5%
 - c. 3%
 - d. 3.5%

Complete the following short answer questions.

4. At what time does the livestock herd have the highest forage quality requirement?
5. What are four types of production functions that determine nutritional needs of livestock?
 - a.
 - b.
 - c.
 - d.

6. Calculate the daily forage dry matter needs of this beef herd:

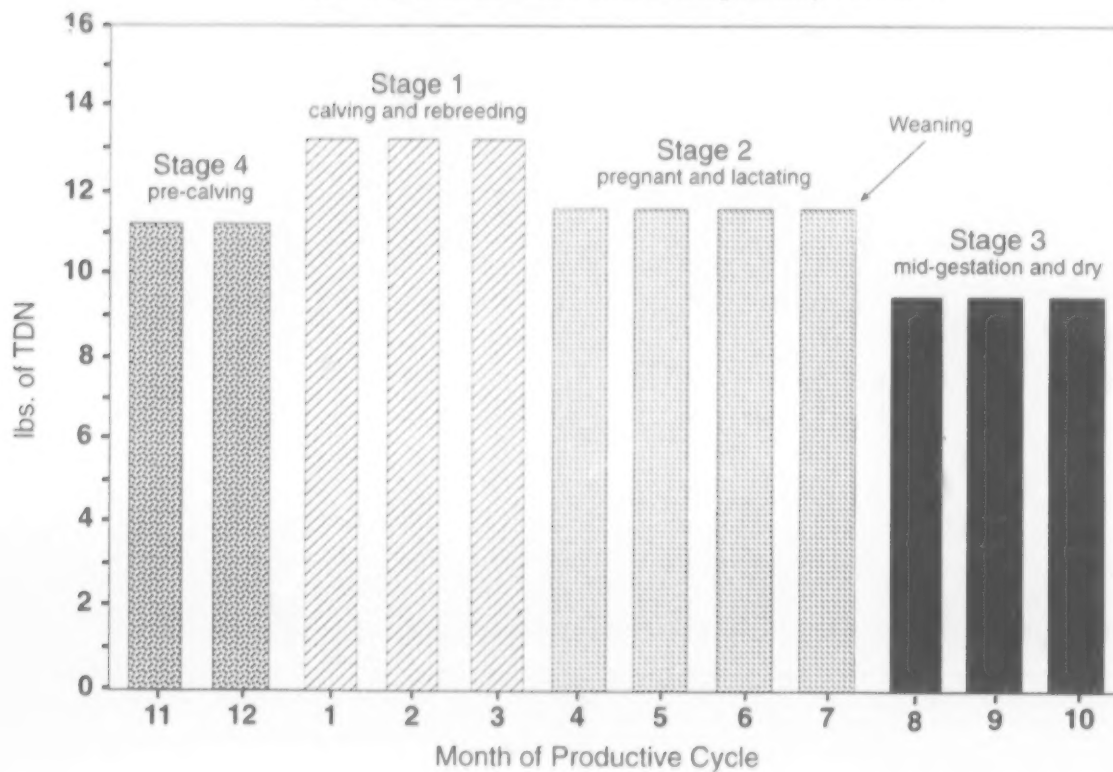
1 bull - 2,500 lbs.; during breeding season

15 heifers - average weight of 700 lbs.

45 lactating cows - average weight of 1,100 lbs.; average milk producers

Energy Needs of a Mature Beef Cow for Spring Calving

Seasonal total digestible nutrient (TDN) requirement
for a 1,100 lb. beef cow with average milk production



Lesson 1: Grasslands and the Nutritional Needs of Livestock Name _____

Calculating Dry Matter Intake

Objective: Calculate daily dry matter intake for a herd.

Calculate the daily dry matter intake of the beef herds in the three following herd situations.

1. Herd 1: 1 bull - 2,200 lbs.; out of breeding season
15 heifers - average weight of 650 lbs.
50 cows - average weight of 1,200 lbs.; superior milk producers

2. Herd 2: 1 bull - 2,000 lbs.; during breeding season
12 heifers - average weight of 750 lbs.
30 cows - average weight of 1,150 lbs.; dry

3. Herd 3: 2 bulls - average weight of 2,100 lbs.; out of breeding season
30 heifers - average weight of 700 lbs.
100 cows - average weight of 1,300 lbs.; average milk producers

UNIT III - GRASSLAND MANAGEMENT PRACTICES

Lesson 2: Grazing Management Systems

Competency/Objective: Determine the optimal grazing methods for a grassland.

Study Questions

1. What are the methods used in harvesting grasslands?
2. What are the advantages and disadvantages of continuous grazing?
3. What are the advantages and disadvantages of rotational grazing?
4. What are the advantages and disadvantages of management-intensive grazing?
5. How does the type of grazing system affect grazing efficiency?
6. What is grazing intensity?
7. What determines the livestock carrying capacity of a grassland?
8. At what stage of growth should grassland be grazed to optimize quality and quantity?
9. How does the type of grazing affect wildlife?
10. How can cool-season grasses, warm-season grasses, and legumes complement each other in a grazing system?
11. How does this grazing system benefit wildlife?

References

1. *Introduction to Grassland Management (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1997, Unit III.
2. Transparency Master
 - a) TM 2.1: Estimated Forage Dry Matter Yield, lbs./acre/in.
3. Activity Sheet
 - a) AS 2.1: Developing a Rotational Grazing System (Instructor)

UNIT III - GRASSLAND MANAGEMENT PRACTICES

Lesson 2: Grazing Management Systems

TEACHING PROCEDURES

A. Review

Lesson 1 reviewed the nutritional needs of livestock. Livestock that live on a grassland get many of the nutrients they need from the plants on which they graze. This lesson will examine the different types of grazing systems and how to identify the best grazing system for a given situation.

B. Motivation

1. With students working in small groups, have them list the different types of grazing systems and any advantages or disadvantages they can think of for each one. The students should consider such factors as seasonal growth, amount of labor involved, quality of plant growth, and amount of land needed in their evaluation of the different grazing systems. Then, talk about the pros and cons of the grazing systems in a class discussion.
2. Have a local cattle producer speak to the class about his or her operation. Discuss the cattle population, grazing capacity of the land, types of forage plants available for grazing, the grazing system used, and the pros and cons of that system.

C. Assignment

D. Supervised Study

E. Discussion

1. Ask the students to name two ways in which grasslands may be harvested. Channel their answers into a discussion of the various types of harvesting.

What are the methods used in harvesting grasslands?

- a) Grazing - by livestock and wildlife
 - 1) Continuous
 - (a) Continuous grazing uses only one pasture to meet the needs of the livestock, which are allowed to graze freely on the plants available.
 - (b) This type of grazing system allows animals to engage in selective grazing, since they have unrestricted access and can pick and choose plants to consume.
 - 2) Rotational
 - (a) Rotational grazing uses at least two grazing units, with animals alternating between the different pastures in a preplanned cycle.
 - (b) Strip grazing and management-intensive grazing are two types of rotational grazing.
 - (c) This type of grazing system tends to prevent selective grazing, since animals are only provided with the amount of forage they require.
- b) Mechanical harvesting - cutting forage for hay, silage, or greenchop

2. Have students describe the advantages and disadvantages of continuous grazing.

What are the advantages and disadvantages of continuous grazing?

- a) Advantages
 - 1) Higher initial performance due to selective grazing
 - 2) Low maintenance
- b) Disadvantages
 - 1) Grassland composition altered by selective grazing
 - 2) Poor forage utilization

3. Ask students to describe rotational grazing. Have them list advantages and disadvantages of this system.

What are the advantages and disadvantages of rotational grazing?

- a) Advantages
 - 1) Maintains desired grassland composition by decreasing selective grazing
 - 2) Provides rest periods allowing for plant regrowth
 - 3) Causes less damage from compaction and animal wastes
 - 4) Increases production per acre
- b) Disadvantages
 - 1) Lower production per animal than selective grazing
 - 2) Requires more time and labor to manage the herd
 - 3) Requires extra fencing to separate pastures into paddocks, increasing costs to the producer

4. Have students describe management-intensive grazing. Ask students to list its advantages and disadvantages.

What are the advantages and disadvantages of management-intensive grazing?

- a) Advantages
 - 1) Maintains desired grassland composition
 - 2) Causes less damage through compaction and animal wastes
 - 3) Higher production per acre than rotational grazing systems
 - 4) Provides for long regrowth periods
 - 5) Causes the operator to come in contact with the herd on a regular basis, allowing him or her to identify and correct potential problems
- b) Disadvantages
 - 1) Requires more time to plan and set up the system
 - 2) Requires extra fencing to separate the pastures into paddocks, increasing costs over continuous grazing
 - 3) Lower production per animal than selective grazing

5. Discuss grazing efficiency in the grazing systems.

How does the type of grazing system affect grazing efficiency?

- a) In continuous grazing systems, only 30 to 35 percent of the total forage produced is eaten by the livestock.
- b) When management-intensive grazing is used, forage utilization can be as high as 65 percent of the forage produced.
- c) To calculate the actual amount of forage dry matter needed in a pasture to feed a herd during a particular season, the seasonal dry matter intake requirements should be divided by the forage utilization rate.

6. Ask students to explain grazing intensity. Discuss the different grazing intensities.

What is grazing intensity?

- a) Grazing intensity refers to the extent to which a plant or grassland is grazed.
 - b) The three levels of grazing intensity are heavy, moderate, and light grazing.
 - 1) Heavy grazing (overgrazing)
 - (a) Exhausts the energy reserves of forages by removing growth too frequently, before it has a chance to replenish itself
 - (b) Marked by the presence of less than four inches of growth in the fall in cool-season grasses and less than eight inches in warm-season grasses
 - 2) Moderate grazing
 - (a) Leaves enough vegetation to maintain the vigor of forage plants and protect soil
 - (b) Indicated by four to eight inches of growth at the end of the season for cool-season grasses and eight to ten inches of growth for warm-season grasses
 - 3) Light grazing (undergrazing)
 - (a) Not beneficial if it results in too much tall, dense forage in the fall, since excessive ground litter can interfere with next year's crop
 - (b) Indicated by more than ten to twelve inches left at the end of the growing season for cool-season grasses and more than twelve to fourteen inches for warm-season grasses
7. The type of grazing system used will partly depend on the carrying capacity of the pasture, which is the ability of a forage to support a specific number of animals throughout a grazing season. Ask students how the livestock carrying capacity of a grassland is determined. Use TM 2.1 as an illustration of dry matter yield.

What determines the livestock carrying capacity of a grassland?

- a) $\text{Carrying Capacity} = \frac{\text{Annual Forage Production} \times \text{Seasonal Utilization Rate}}{\text{Average Daily Intake} \times \text{Length of Grazing Season}}$
 - b) Annual forage production - Amount of forage dry matter produced per acre in a year
 - c) Seasonal utilization rate - Percentage of the forage produced that will be consumed by the herd in one year
 - d) Average daily intake - Percentage of the animal's body weight that is consumed in forages on a daily basis
 - e) Length of the grazing season - Days of grazing per year
8. Forage quality and quantity at the time of harvest is very important to production. Ask the students what the stage of growth should be when forage is grazed.

At what stage of growth should grassland be grazed to optimize quality and quantity?

Optimum forage harvesting would take place during the vegetative (leafy) stage, when forage growth is continuous and nutritional quality is high; the vegetative stage ends when plant reproduction begins.

9. Wildlife are greatly affected by the type of grazing system utilized, since they are dependent on the grassland for food and shelter. Have students discuss the effect of various types of grazing on wildlife.

How does the type of grazing affect wildlife?

- a) Continuous grazing - This grazing system is not beneficial to wildlife, although special provisions such as brush piles and fence lines with tall vegetation may aid animals.

- b) Rotational grazing - During rest periods, pastures provide habitat and food for wildlife. Rotational grazing systems also favor more diversity in grassland composition, which improves the food and cover available to wildlife and tends to protect wildlife habitat in woody draws and along bodies of water.
10. Discuss how cool-season grasses, warm-season grasses, and legumes can work together in a grazing system.

How can cool-season grasses, warm-season grasses, and legumes complement each other in a grazing system?

- a) Ideally, one-third of the grazing system should consist of warm-season grasses. They begin the bulk of their growth in June and July, when cool-season grasses are finishing their spring growth.
 - b) Legumes can lengthen the grazing season of cool-season grasses because they will often grow longer in the summer. They also provide higher quality forage, fertilize the ground, and increase yields.
 - c) Cool-season grasses reach another peak in forage growth as warm-season grass production declines.
11. Discuss how a grazing system that consists of cool-season grasses, warm-season grasses, and legumes can benefit wildlife. Have students complete the activity outlined on the instructor guide sheet in AS 2.1.

How does this grazing system benefit wildlife?

- a) By the time warm-season grasses are ready to be harvested (hayed or grazed), most wildlife species are finished using them for reproduction.
- b) At this time, cool-season grasses are being rested and can be used for cover or nesting.

F. Other Activities

G. Conclusion

Forages can be harvested either by grazing or mechanical harvesting. Continuous grazing is a low-maintenance system in which the herd remains in one pasture for the majority of the grazing season. Rotational grazing involves the intensive management of pastureland and animals, since the animals are moved between two or more pastures or paddocks based on forage quality, quantity, and utilization. A grazing system that combines cool-season grasses, warm-season grasses, and legumes benefits both livestock and wildlife.

H. Answers to Activity Sheet

AS 2.1

Answers will vary.

I. Answers to Evaluation

- 1. d
- 2. a
- 3. e
- 4. c
- 5. d
- 6. a
- 7. d

- 8. b
- 9. a

- 10. By the time warm-season grasses are ready to be hayed or grazed, most wildlife species are finished using them for reproduction. At this time, cool-season grasses are being rested and can be used for cover or nesting.
- 11. The advantages of rotational grazing are that it maintains desired grassland composition, provides rest periods allowing for plant regrowth, causes less damage through compaction and animal wastes, and increases production per acre. The disadvantages are that it has lower production per animal than selective grazing, requires more time and labor to manage the herd, and requires extra fencing to create paddocks, which increases costs.
- 12. The rotational systems provide food and habitat for wildlife while the forages are being regrown during rest periods. Rotational grazing systems also tend to protect wildlife habitat in woody hollows and along bodies of water and favor more diversity in grassland composition, which improves the food and cover available to wildlife.
- 13. Ideally, one-third of the grazing system should consist of warm-season grasses. They begin the bulk of their growth in June and July, when cool-season grasses are finishing their spring growth. Legumes can lengthen the grazing season of cool-season grasses because they will often grow longer in the summer. They also provide higher quality forage, fertilize the ground, and increase yields. Cool-season grasses reach another peak in forage growth as warm-season grass production declines.

EVALUATION

Match the word or words on the right with the best definition on the left.

- | | |
|--|------------------------------|
| ___ 1. Number of animals that can be supported by a grazing unit for the whole grazing season | a. Rotational grazing |
| ___ 2. Grazing system in which the pasture is divided into two or more paddocks and animals alternate between them in a preplanned cycle | b. Intensive grazing |
| ___ 3. Grazing in which the animals pick and choose the plants they eat | c. Continuous grazing |
| ___ 4. Grazing system in which livestock are grazed on one pasture unit with unrestricted access for the majority of the grazing season | d. Carrying capacity |
| | e. Selective grazing |
| | f. Seasonal utilization rate |

Circle the letter that corresponds to the best answer.

5. What are the two basic methods of harvesting?
- a. Strip and intensive
 - b. Rotational and continuous
 - c. Hay and silage
 - d. Grazing and mechanical
6. In which grazing system is the herd moved the least?
- a. Continuous grazing
 - b. Rotational grazing
 - c. Intensive grazing
 - d. Strip grazing
7. For warm-season grasses, what height indicates heavy grazing?
- a. Anything less than four inches
 - b. Anything less than five inches
 - c. Anything less than seven inches
 - d. Anything less than eight inches

8. At what stage of growth should grasslands be harvested?
- a. Stage 1 (vegetative)
 - b. Stage 2 (boot/bud) heading, and mature seed stages in grasses. In legumes, they are the vegetative, bud, bloom, and mature seed stages
 - c. Stage 3 (heading/bloom)
 - d. Stage 4 (mature seed)
9. What is the grazing efficiency in management-intensive grazing systems?
- a. Up to 65 percent
 - b. Up to 75 percent
 - c. Up to 80 percent
 - d. Up to 90 percent

Complete the following short answer questions.

10. How does a grazing system with cool-season and warm-season grasses benefit wildlife?
11. What are the advantages and disadvantages of rotational grazing?
12. Why is a rotational grazing system more beneficial for wildlife?
13. How do cool-season grasses, warm-season grasses, and legumes work together in a grazing system?

Estimated Forage Dry Matter Yield, lbs./acre/in.

Stand Condition			
Pasture Species	Fair	Good	Excellent
Tall fescue + N	250-350	350-450	450-550
Tall fescue + legumes	200-300	300-400	400-500
Smooth brome grass + legumes	150-250	250-350	350-450
Orchardgrass + legumes	100-200	200-300	300-400
Bluegrass + white clover	150-250	300-400	450-500
Mixed pasture	150-250	250-350	

Source: 1995 Missouri Grazing Manual

Lesson 2: Grazing Management Systems

Developing a Rotational Grazing System

Objective: Develop a rotational grazing system based on the needs of an operation.

Procedure:

1. The students should identify an existing operation that they want to use for the activity, or the instructor can provide the class with an operation to use if this is not an option. They will need to research the pastureland and its current conditions, which will require visiting the location and looking at area maps and soil surveys.
2. Have the students document the current conditions of the operation. They should note the strengths and weaknesses of the pasture and the livestock operation.
3. Ask students to recommend different ways to make a better use of resources such as land, water, and forages for livestock production.
4. Have the students document the course of action that would best incorporate improvements in the existing operation.

UNIT III - GRASSLAND MANAGEMENT PRACTICES

Lesson 3: Harvesting and Storing Forage Crops

Competency/Objective: Determine methods for harvesting and storing forage crops.

Study Questions

1. Why would forages be mechanically harvested?
2. What are the two main methods of mechanically harvesting forage crops?
3. What are the different methods of storing harvested forage crops?
4. What factors affect the quality of stored forage crops?
5. At what stage of growth should grasslands be mechanically harvested to optimize quality and quantity?

References

1. *Introduction to Grassland Management (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1997, Unit III.
2. Activity Sheet
 - a) AS 3.1: Sampling Hay

UNIT III - GRASSLAND MANAGEMENT PRACTICES

Lesson 3: Harvesting and Storing Forage Crops

TEACHING PROCEDURES

A. Review

Lessons 1 and 2 examined the nutritional needs of the livestock and how they can be met through grazing. Whenever the grazed forage does not meet the needs of the herd, supplemental feeding is used to sustain the herd. If forages are harvested from the grassland and stored, they can be used for supplemental feeding. In this lesson, the methods of harvesting and storing forages will be studied.

B. Motivation

Ask students to share any experiences that they have had with harvesting and storing forages. Bringing in samples of silage and hay may help to spur discussion. If students do not have experience with harvesting, discuss what information they do know about storing forages.

C. Assignment

D. Supervised Study

E. Discussion

1. Grazing meets the nutritional needs of the herd while the forage is in the vegetative state. Ask students why a grassland might be mechanically harvested instead of grazed.

Why would forages be mechanically harvested?

- a) To preserve the quality of the forage by maintaining the vegetative state
 - b) To optimize forage utilization during times when forage production is greater than the herd can consume, maximizing yield
 - c) To meet the nutritional needs of the herd when pastures are dormant
 - d) To sell the forage if it is not needed by the herd
2. Two main methods of harvesting forages may be used; have students name the two methods. Point out that hay and silage vary in the amount of moisture they contain and the storage methods used for each.

What are the two main methods of mechanically harvesting forage crops?

- a) Harvesting for hay - The green forage is harvested at low moisture levels and cured by drying.
 - b) Harvesting for silage - The green forage is converted into moist, succulent livestock feed through fermentation that takes place during storage.
3. When forages are stored, maintaining the quality of the forage and controlling costs are of the utmost importance. Ask students to describe the different methods of storing harvested forage crops.

What are the different methods of storing harvested forage crops?

- a) Hay - formed into stacks, square bales, or round bales
 - 1) Barn - provides the most weather protection

- 2) Temporary cover - prevents water penetration and is inexpensive; used for large round bales or loose stacks
- 3) Field - provides the least expensive storage, but weather exposure can cause excessive loss of quality
- t) Silage - stored in silos to prevent spoilage and quality loss due to leaching of nutrients
 - 1) Vertical - have low storage losses, can be located near livestock, and adapt to automatic feeding
 - (a) Conventional - made of metal, concrete, or tile
 - (b) Oxygen-limited - sealed or lined with fused glass; have even lower storage losses but cost more per cubic foot
 - 2) Horizontal - easier to construct and cost less than vertical silos, but are also subject to more leaching of nutrients and require extensive packing of silage
 - (a) Bunker - consists of a concrete floor with concrete or plank walls above ground level
 - (b) Trench - dug into well-drained ground or hillside; may have soil or concrete for floor and walls
 - (c) Stack - used for temporary or emergency storage; consists of a compacted pile of silage placed on the ground or concrete floor; usually has high spoilage losses, so silage should be used as soon as possible
4. Forage quality is dependent on many different factors. Ask students to list these factors. Have students complete AS 3.1.

What factors affect the quality of stored forage crops?

- a) Moisture content - can cause mold in hay if it is too high or leaf loss if it is too low; can cause mold in silage if it is too low
- b) Losses in storage - caused by improper storage and lack of protection from the environment
- c) Species composition - have different storage qualities as well as different palatability and nutritional benefits to livestock
- d) Stage of growth at harvest
5. The production goal of all harvesting is to produce the forage with the highest nutritional value possible. Ask students to identify the best time to harvest to optimize quality and quantity.

At what stage of growth should grasslands be mechanically harvested to optimize quality and quantity?

Optimum forage harvesting takes place during the boot (grasses) and early bloom (legumes) stages, depending on the vegetative growth.

F. Other Activities

Have students develop their own silo models that will prevent spoilage and quality loss due to leaching of nutrients. Place silage samples in the models and check them at a later date to determine the quality of storage.

G. Conclusion

Forage harvesting and storage is a crucial component of livestock management. The two methods of harvesting forages produce hay and silage, which may be stored in many different ways. Forage quality and costs should be considered when selecting the best method of storage for a specific operation. Harvesting time, moisture content, species composition, and storage method all affect the quality of the harvested forage. All forages should be harvested while in the vegetative growth phase during the boot stage in grasses and the early bloom stage in legumes.

H. Answers to Evaluation

1. c
2. c
3. d
4. b
5. d
6. Hay has low moisture levels, while silage is fermented to form a moist, succulent livestock feed. Hay is cured by drying it before it is stored, while silage is cured through fermentation that takes place during storage.
7. Forages should be mechanically harvested and stored to preserve the quality and quantity of the forage by maintaining the vegetative state, to optimize forage utilization during times when forage production is more than the herd can consume, to meet the nutritional needs of the herd when pastures are dormant, and to sell if not needed by the herd.

EVALUATION

Circle the letter that corresponds to the best answer.

1. During which stage of growth should legumes be mechanically harvested?
 - a. Boot
 - b. Leafy
 - c. Early bloom
 - d. Mature seed
2. _____ silos are expensive to construct but reduce loss of forage quality during storage.
 - a. Conventional
 - b. Horizontal
 - c. Oxygen-limited
 - d. Trench
3. What type of silo has no walls, so the silage in it must be used quickly to reduce spoilage?
 - a. Trench
 - b. Bunker
 - c. Conventional
 - d. Stack
4. To maintain the highest quality, hay should be stored where?
 - a. In a field
 - b. In a barn
 - c. In a bunker
 - d. Under temporary cover
5. Which of the following factors does not affect the quality of stored forage crops?
 - a. Moisture content
 - b. Stage of growth at harvest
 - c. Protection from environment
 - d. Nutrient content

Complete the following short answer questions.

6. What is the difference in moisture content between hay and silage? How is each one cured?

7. Why should a livestock operation mechanically harvest and store forages?

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Lesson 3: Harvesting and Storing Forage Crops

Name _____

Sampling Hay

Objective: To take hay samples for forage quality analysis.

Materials:

Core sampler
Hay bales
Plastic freezer bag
Tape

Procedure:

1. Randomly select twenty bales from the same lot of hay.
2. Take a sample from each bale. Drill horizontally in the center of the end of a square bale or in the side of a round bale.
3. Put the samples together in a plastic bag. Tape the bag shut. Your instructor will send the samples in for testing.

UNIT III - GRASSLAND MANAGEMENT PRACTICES

Lesson 4: Wildlife Management

Competency/Objective: Develop a better understanding of the management practices needed to manage both livestock and wildlife on grasslands.

Study Questions

1. What wildlife species depend on Missouri grasslands?
2. What are the basic habitat needs of wildlife?
3. What factors affect the value of grasslands for wildlife?
4. How can management practices be adapted for wildlife?
5. How is existing wildlife habitat evaluated?
6. Why are grassland management plans written for quail and rabbits?

References

1. *Introduction to Grassland Management (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1997, Unit III.
2. Activity Sheets
 - a) AS 4.1: Habitat Evaluation
 - b) AS 4.2: Grassland Evaluation for Wildlife Habitat

UNIT III - GRASSLAND MANAGEMENT PRACTICES

Lesson 4: Wildlife Management

TEACHING PROCEDURES

A. Review

The last lesson discussed using mechanical methods like haying and chopping for silage to harvest forages for livestock feed. Management practices for livestock production like haying and grazing can be compatible with wildlife conservation. Wildlife management can be emphasized in grassland operations without sacrificing forage yields. Grassland owners should include the best practices for both livestock and wildlife in their management plans to improve profits and care for their land. This lesson explores the types of wildlife found in the grassland environment, their needs, and how to meet those needs while achieving production goals.

B. Motivation

Take students on a field trip to different grassland sites and compare poorly managed grassland to well-managed grassland. What problems could reduce livestock production? What are some corrective actions that could be taken? How do these problems and solutions affect wildlife?

C. Assignment

D. Supervised Study

E. Discussion

1. Ask students to name wildlife species that use grasslands.

What wildlife species depend on Missouri grasslands?

- a) Greater prairie chicken
- b) Upland sandpiper
- c) Meadowlark
- d) Rabbit
- e) Quail
- f) Pheasant
- g) Deer
- h) Turkey

NOTE: Other examples of wildlife species found on grasslands could include the prairie king snake, cowbird, field mice, bobcat, coyote, box turtle, and hawks.

2. Ask students what things they would need to survive if they were lost in the wilderness. Compare the needs of wildlife to those of humans. Discuss how the needs of livestock and wildlife are similar. Both must obtain what they need from the environment.

What are the basic habitat needs of wildlife?

- a) Water
 - 1) Water comes from rainfall, rivers and streams, plants, and farm ponds.
 - 2) Wildlife can use water supplies for livestock, with some modifications.

- 3) Control livestock to keep them from damaging water supplies.
 - b) Food
 - 1) Land next to a pasture can be critical to the carrying capacity for wildlife.
 - 2) Producers should supply food for wildlife during winter by avoiding fall plowing and leaving standing seed heads of grasses and grains.
 - c) Cover
 - 1) Cover is important for protection, nesting, and roosting.
 - 2) Wildlife species use four types of cover.
 - (a) Soft - nonwoody growth of grasses, legumes, and forbs
 - (b) Shrubby - woody brush and shrubs with multiple stems growing from a common base that are generally less than twenty feet tall
 - (c) Hard - trees and shrubs twenty or more feet tall
 - (d) Escape - especially dense shrubby or hard cover where wildlife can escape predators
3. Discuss the characteristics of a grassland that affect how wildlife can use it.

What factors affect the value of grasslands for wildlife?

- a) Type of grassland
 - 1) Cool-season pasture - normally at its peak quality and ready for harvest at the height of the nesting season, which creates problems for ground-nesting birds
 - 2) Native warm-season pasture
 - (a) Provides better food and cover when properly managed than cool-season pasture
 - (b) Not ready for harvest until midsummer, when most ground-nesting wildlife have produced their broods
 - 3) Native grassland
 - (a) Dominated by a mixture of native warm-season grasses with a good complement of native legumes and forbs
 - (b) May have hundreds of plant species, attracting many species of wildlife
 - b) Plant composition - A variety of plants generally makes the grassland more productive and enhances wildlife habitat by improving the quality of cover and the available food supply.
 - c) Size of the grassland - Different species require grasslands of different sizes.
 - d) Use of the grassland - This is probably the most critical factor affecting the value of the grassland for both wildlife and livestock.
 - 1) Haying
 - 2) Grazing
4. Ask students how the different grassland management practices might affect a particular species (e.g., rabbits). Discuss how they can be adapted to benefit wildlife.

How can management practices be adapted for wildlife?

- a) Grazing
 - 1) Continuous grazing is less beneficial for wildlife than rotational grazing.
 - 2) Rotational grazing allows managers to move livestock when necessary to give the valuable palatable plants a resting period in which to grow and multiply.
 - 3) Rotational grazing allows grazing to be timed to benefit both livestock and wildlife.
 - (a) Schedule prime nesting areas for rest periods when wildlife need them.

- (b) Arrange to have livestock graze next to nesting areas so chicks will have access to open ground with a different mix of foods next to good soft cover.
 - (c) Schedule paddocks next to woody cover or other wintering grounds for grazing early in the season so they can regrow cover and seed.
 - 4) A moderate grazing intensity is most beneficial because it provides adequate food and cover while opening travel lanes between plants and creating some bare ground for seed-gathering and dusting areas.
 - b) Haying - Grassland managers can adjust location, timing, and mowing height to leave enough food and cover as needed.
 - 1) Leave the outer thirty feet of hayfields standing or cut it later.
 - 2) Have a balance of warm- and cool-season pastures with different harvest dates so food and cover are always available.
 - 3) Stagger haying schedules so harvest takes place over a longer period.
 - c) Fertilizing
 - 1) It can increase grassland production and improve the nutritional quality of food, but other management practices must leave enough food and cover.
 - 2) Native grasslands do not usually benefit from fertilizing, which can change plant composition and allow weeds to take over.
 - d) Overseeding with legumes
 - 1) Seeding pastures with legumes helps wildlife by adding diversity to the types of food and cover available.
 - 2) They should not be added to native grasslands because these areas already contain legumes and forbs more suitable to the site.
 - e) Irrigation - Irrigation could benefit wildlife as an additional source of water, but it could be harmful if it occurred during critical times.
 - f) Reestablishing native warm-season grasses - Converting much cool-season pasture to native warm-season grasses can benefit wildlife since they have adapted to these grasses.
 - g) Prescribed burning - Prescribed burning helps in maintaining a vigorous grassland community (e.g., maintaining or increasing the native legumes used by wildlife).
5. Wildlife managers use standard guides to help landowners assess wildlife habitat. Ask students what factors might be used in evaluating a grassland for its capacity to support wildlife. Have students complete AS 4.1 or 4.2. AS 4.2 is tied directly to this study question, while AS 4.1 provides a more general evaluation.

How is existing wildlife habitat evaluated?

Wildlife habitat can be evaluated by looking at eight factors.

- a) Extent of the border surrounding the grassland
 - b) Percent of the field covered by winter or escape cover
 - c) Percent of canopy coverage from shrubs and herbaceous vegetation six to eighteen inches tall
 - d) Grazing pressure
 - e) Percent of the ground covered or shaded by legumes
 - f) Plant composition
 - g) Distance from the center of the field to the edge of the nearest crop field
 - h) Percent of the grazing unit that is within 250 feet of dense woody cover or ungrazed woodland
6. Most wildlife management plans for grasslands are written for quail and rabbits. Exceptions include where species of extra importance or need occur (such as the prairie chicken) or

where special habitats may be involved (like remnant prairies). Ask students to explain why good habitat for rabbits and quail is often considered ideal for other types of wildlife.

Why are grassland management plans written for quail and rabbits?

- a) Rabbits and quail are popular game animals.
- b) They require a relatively small acreage, so good wildlife management plans can be written for both large and small farms.
- c) They are indicator species; if a habitat benefits them, many others will prosper since their needs are similar to those of a variety of other species.

F. Other Activities

Show the video "Conservation Planning for Wildlife" (13½ min., 1989), part of the *Farming and Wildlife* series available from the MDC Media Library. Other videos from this series, such as "Prairie Chicken" (14¾ min.) and "Ring-Necked Pheasant," can also be used to show variations in management for different species.

G. Conclusion

Wildlife that live within the grassland community must have their needs for water, food, and cover met by the grassland. Producers can adopt management practices to accommodate wildlife without sacrificing forage production for livestock.

H. Answers to Activity Sheets

AS 4.1

Answers will vary.

AS 4.2

Answers will vary.

I. Answers to Evaluation

- 1. d
- 2. b
- 3. d
- 4. c
- 5. d
- 6. b

- 7. Students may list any three of the following species: greater prairie chicken, upland sandpiper, meadowlark, rabbit, quail, pheasant, deer, or turkey.
- 8. Escape cover is especially dense shrubby or hard cover where wildlife can escape predators.
- 9. Native warm-season pasture provides better food and cover when properly managed than cool-season pasture. It is also not ready for harvest until midsummer, when most ground-nesting wildlife have produced their broods.
- 10. Students may list any two of the following factors: extent of the border surrounding the grassland, percent of the field covered by winter or escape cover, percent of canopy coverage

from shrubs and herbaceous vegetation six to eighteen inches tall, grazing pressure, percent of the ground covered or shaded by legumes, plant composition, distance from the center of the field to the edge of the nearest crop field, and percent of the grazing unit that is within 250 feet of dense woody cover or ungrazed woodland.

UNIT III - MANAGEMENT PRACTICES

Name _____

Lesson 4: Wildlife Management

Date _____

EVALUATION

Circle the letter that corresponds to the best answer.

1. What is soft cover?
 - a. Trees and shrubs twenty or more feet tall
 - b. Woody brush and shrubs generally less than twenty feet tall
 - c. Any mixture of shrubs, brush, and trees
 - d. Nonwoody growth of grasses, legumes, and forbs
2. Rabbits and quail are indicator species, which are:
 - a. Species that indicate that another species lives on the grassland
 - b. Species that indicate that other species will prosper in a habitat
 - c. Species used in finding other wildlife in a particular area
 - d. Species that indicate the maximum carrying capacity for wildlife
3. On which type of grassland is overseeding with legumes unnecessary because it already contains suitable legumes and forbs?
 - a. Cool-season pasture
 - b. Native warm-season pasture
 - c. Nonnative warm-season pasture
 - d. Native grassland
4. Which of the following is a way that haying can be managed to accommodate wildlife?
 - a. Mow the entire field at once.
 - b. Plant only cool-season pastures for haying.
 - c. Stagger haying schedules to extend the harvesting period.
 - d. Schedule prime nesting areas to be cut at the end of the harvesting period.
5. What is the most critical factor affecting the value of the grassland for wildlife?
 - a. Type of grassland
 - b. Plant composition
 - c. Size of the grassland
 - d. Use of the grassland
6. Which grazing intensity is the most beneficial for wildlife?
 - a. Heavy
 - b. Moderate
 - c. Light
 - d. Constant

Complete the following short answer questions.

7. What are three wildlife species found in grasslands?

8. What is escape cover?

9. How does native warm-season pasture benefit wildlife?

10. What are two of the factors examined when evaluating a grassland for wildlife habitat?

Lesson 4: Wildlife Management

Name _____

Habitat Evaluation**Objective:** Evaluate the value of a grassland for wildlife.

The form provided can be used to evaluate the value of a grassland for wildlife. It lists factors that are less favorable to wildlife on the left and factors that are more favorable on the right. The central numbered columns indicate the degree to which conditions in the area match the statements in that row. If they closely match the statement on the left, place a check mark in the "1" column. If they match the statement on the right, check the "5" column. Indicate partial agreement by checking the appropriate column.

When each factor has been evaluated, count the number of checks in each column and multiply by the number of the column. Add the totals of all the columns, and use this sum as the numerator over 60 to form a ratio. Reduce the fraction to its lowest form. This indicates the degree to which the area approaches the ideal (60/60 or 1/1 would be ideal).

Key Questions:

1. What is the overall rating of the grassland? Would it be valuable for wildlife?

2. In which areas did the grassland receive low scores?

3. What could be done to improve a grassland in these areas?

1 2 3 4 5

1. Large patches of bare soil between grass plants						1. Ground nearly covered with grasses or smaller plants
2. All grass alike; other plants absent or nearly so						2. Wide variety of broad-leaved plants growing among a variety of grasses
3. Soil hard and packed						3. Topsoil loose and easily probed by finger
4. Topsoil thin, with much small gravel throughout soil						4. Topsoil deep, with few rocks in most of area
5. Little evidence of small animals using the area						5. Many small animal burrows in soil and tunnels through grass
6. Grass forms an unbroken, uniform-height stand						6. Grass "clumpy;" several types with different heights
7. Much of soil exposed to direct sunlight						7. Dead grass and leaves shade most of ground
8. Topsoil light brown, yellow, or red						8. Topsoil dark brown
9. Insects absent, or with one type very numerous						9. Variety of insects (butterflies, bees, grasshoppers, beetles) with no species greatly dominating
10. Rock outcrops absent or composed of small, rounded rocks						10. Outcroppings of large flat rocks along hilltops and waterways
11. Land very flat; no relief from wind and sun						11. Land somewhat hilly; north side gives relief from sun and wind
12. No trees in area, even along waterways						12. Variety of trees along major waterways
Column Totals						(Sum)
						____ = ____ 60

123

Lesson 4: Wildlife Management

Name _____

Grassland Evaluation for Wildlife Habitat

Objective: Evaluate a specific grassland for its value to cottontail rabbits and bobwhite quail.

A grassland manager who is interested in both livestock and wildlife production must be able to recognize the habitat requirements of both. Remembering that fences do not confine wild animals is important. Cover such as brush piles and shrubby thickets may be located in areas next to the grassland while additional food and cover can be provided within the grassland unit.

The following factors are considered when evaluating a specific tract of grassland, pasture, or hay field. The objective of this exercise is to identify limiting factors that can be overcome to improve the habitat for rabbits and quail.

Evaluate the quality of a grassland chosen by your instructor. A field or pasture unit should be rated on the conditions within the fenced area only. An aerial photograph of a specific grassland unit may be helpful in identifying habitat components in adjacent fields. A brief explanation follows each appraisal category.

APPRAISAL OF EXISTING CONDITIONS1. _____ **EXTENT OF BORDER**

- | | |
|----------------------------------|--------------------------------------|
| A. No border (see note 1) | D. Border along three sides |
| B. Border along one side | E. Border around entire field |
| C. Border along two sides | |

A border cannot exist under grazing (pasture) conditions, since livestock graze from fence row to fence row. The field being appraised is the area that is being grazed between the fences that enclose it. For this category, ignore any vegetation that is outside the fenced area being grazed. Habitat components in adjacent fields will be evaluated separately within that field.

2. _____ **PERCENT OF FIELD COVERED BY WINTER OR ESCAPE COVER**

- A. **No cover is present.** The field is lacking any usable thickets, blackberry patches, or dense, brushy cover.
- B. **One to 10 percent of the field has winter/escape cover.** This amount of cover is considered marginal and is valuable to wildlife only if livestock have not trampled and grazed through it. Look into the thicket to see if a rabbit could escape from its predators or if they could pass through it easily.
- C. **Field is less than ten acres in size.** Choose this category only if the fence rows consist of very dense escape cover as described in "B" above. If not, select "A," since this field would be of little value to wildlife for escape cover.

3. _____ **PERCENT CANOPY COVERAGE OF SHRUBS AND HERBACEOUS VEGETATION 6 TO 18 INCHES TALL**

- A. **Less than 25 percent coverage**
- B. **26 to 75 percent coverage**
- C. **More than 76 percent coverage**

4. _____ **GRAZING PRESSURE**

- A. **Heavy** - The stocking rate is heavy, leaving forage that is less than three inches in height.
- B. **Moderate** - The forage is three to eight inches in height.
- C. **Light** - The stocking rate is light, leaving tall forage on the unit.
- D. **Rotational** - Paddocks or grazing cells have been established to allow the rotation of livestock.

5. _____ **PERCENT OF GROUND COVERED OR SHADED BY LEGUMES**

- A. **5 percent or less**
- B. **6 to 50 percent**
- C. **51 percent or more**

6. _____ **PLANT COMPOSITION**

- A. **Tall fescue (more than 90 percent)**
- B. **Mixed cool-season grass (10 percent or less legumes)**
- C. **Cool-season grass dominant (10 to 25 percent legumes)**
- D. **Cool-season grass and legumes (26 to 60 percent legumes)**
- E. **Legumes dominant (75 percent or more legumes)**
- F. **Warm-season grasses dominant (25 percent or less other species)**

7. _____ **DISTANCE FROM CENTER OF FIELD TO EDGE OF NEAREST CROP FIELD**

- A. **More than 500 feet to crop field**
- B. **250 to 499 feet to chiseled or disked crop field**
- C. **Less than 249 feet to chiseled or disked crop field**
- D. **250 to 500 feet to crop field with no fall tillage or with winter wheat crop**
- E. **Less than 249 feet to crop field with no fall tillage or with winter wheat crop**

8. _____ **PERCENT OF GRAZING UNIT THAT IS WITHIN 250 FEET OF DENSE WOODY COVER OR UNGRAZED WOODLAND**

- A. **Less than 25 percent**
- B. **26 to 50 percent**
- C. **51 to 75 percent**
- D. **76 to 100 percent**

UNIT III - GRASSLAND MANAGEMENT PRACTICES

Lesson 5: Grassland Management Plan

Competency/Objective: Develop a grassland management plan.

Study Questions

1. What is needed to develop a grassland management plan?
2. What are the steps in developing a grassland management plan?
3. How do landowners select a grazing system to suit their needs?
4. How do landowners decide what type of forage is to be used?
5. What are some ways to maintain or renovate a grassland?

References

1. *Introduction to Grassland Management (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1997, Unit III.
2. Activity Sheets
 - a) AS 5.1: Determining Grassland Condition
 - b) AS 5.2: Evaluating a Grassland

UNIT III - GRASSLAND MANAGEMENT PRACTICES

Lesson 5: Grassland Management Plan

TEACHING PROCEDURES

A. Review

The last lesson examined how to best manage grasslands for wildlife habitat. In this lesson, much of the information learned in previous units will be pieced together to develop a grassland management plan.

B. Motivation

Have students visit a livestock operation that monitors production closely to show them that the better grassland management inventory, the better the management.

C. Assignment

D. Supervised Study

E. Discussion

1. Ask students what information is needed to complete the grassland management plan. Discuss with students why each of these items is necessary. Review the previous units showing the students how what they have learned fits together.

What is needed to develop a grassland management plan?

- a) Soil test results - analysis of soil fertility
 - b) Soil identification - information on the type of soil and drainage and use classification
 - c) Maps - visual representation of the land; includes types of soil and physical layout, such as water, slope, and drainage
 - d) Plant composition - quality, quantity, and variety of plants in a plot
 - e) Livestock needs - nutritional needs based on species, age, sex, production level, and environment
 - f) Herd inventory - the quantity of animals within each classification
2. Ask students to outline the steps in developing a grassland management plan, based on what they have learned in previous lessons.

What are the steps in developing a grassland management plan?

- a) Acquire an aerial photograph of the grassland and outline the fields included in the plan.
 - b) Complete soil tests for each field.
 - c) Conduct a complete grassland inventory looking at plant composition to determine the quality and quantity of pasture available and assist in calculating stocking rates.
 - d) Evaluate wildlife habitat.
 - e) Select a grassland management plan, choosing a grazing system and deciding what areas should be grazed and what fields should be mechanically harvested.
3. Ask students what different factors would affect or change the grazing system used. Point out that these are the same factors used in selecting the appropriate system for a grassland.

How do landowners select a grazing system to suit their needs?

The selection of a grazing system is based on the interaction between the soil, environment, resources, herd needs, wildlife, and plants.

4. Discuss with students what plants need for optimum growth and what livestock need from forages. These two factors will determine the type of forage needed.

How do landowners decide what type of forage is to be used?

- a) Forage management - The goal is persistence of stand and acceptable yields.
 - 1) Climate
 - 2) Site conditions
 - b) Livestock management - The goal is profitable gains.
 - 1) Nutrient needs
 - 2) Intensity of harvest/grazing
 - c) Forage management should be considered first in selecting a forage.
5. Ask students what steps they might take if they wanted to improve a pasture by changing the plant composition. Have students complete AS 5.1 and/or AS 5.2.

What are some ways to maintain or renovate a grassland?

- a) Testing the soil and amending it
 - 1) Spreading fertilizer
 - 2) Liming
 - 3) Disking
- b) Suppressing or destroying existing unwanted plants, either chemically or mechanically by disking or plowing
- c) Introducing legumes
 - 1) Overseeding
 - (a) White clover, annual lespedeza, red clover, and birdsfoot trefoil are most often used; they may be used in combination with each other.
 - (b) It involves broadcasting legumes into an existing pasture in which the stand is thinned or grazed close to the ground.
 - (c) It is usually done in late winter or early in the fall.
 - 2) No-till planting
 - (a) This method involves using a no-till drill, which can place the seed in the ground at an optimal depth without the ground being worked up.
 - (b) It is sometimes used to establish additional grass.
 - (c) Its advantages include lower seeding rates, precise placement of seed, reduction in the loss of valuable organic matter due to tillage; reduction in soil erosion is one of its greatest benefits.
- d) Prescribed burning
 - 1) Used most commonly for native warm-season grasses
 - 2) Removes the previous year's growth, keeps invading woody plants in check, and reduces competition from invading cool-season grasses
 - 3) Usually conducted in the spring
 - 4) Encourages fast and vigorous growth right after the burn, since it releases nutrients that are locked up in the previous year's growth
 - 5) Must be used safely, with training from the NRCS or MDC

F. Other Activities

1. Design hypothetical situations where the students are given the current conditions of a livestock operation to determine ways to improve its yield and profitability.

2. Visit a prescribed burn for observation. If the actual burn cannot be attended, visit a field that has been burned and compare it with one nearby that has not.
3. Show the videos "Establishing Warm-Season Grasses" (15 min., 1989) and "Private Prairie Restoration" (5½ min., 1989) from the *Farming and Wildlife* series #1, both available from the MDC Media Library.

G. Conclusion

For a grassland management program to be profitable, many aspects of production must be considered when making decisions. An inventory of current conditions helps a grassland manager make educated choices about grazing systems, forage selection, and renovation plans. The complexity of these decisions is due to the many different factors that influence the grassland.

H. Answers to Activity Sheets

AS 5.1

Answers will vary.

AS 5.2

1. d
2. a
3. c
4. b
5. d
6. 017
7. 1.1
8. c
9. a
10. a
11. a
12. c
13. c
14. a
15. c
16. c
17. c

18.	<u>Adapted</u>	<u>Not Adapted</u>
a.	<u>X</u>	_____
b.	<u>X</u>	_____
c.	<u>X</u>	_____
d.	<u>X</u>	_____
e.	<u>X</u>	_____
f.	<u>X</u>	_____
g.	<u>X</u>	_____
h.	<u>X</u>	_____
i.	<u>X</u>	_____
j.	<u>X</u>	_____

19. a
20. a

21. a
22. b
23. b
24. a
25. a

26. This moderately grazed pasture offers very little food or cover for rabbits and quail due to its location and plant composition.

27. b
28. b

29. a. 1,392 lbs.
- b. 2,070 lbs.
- c. 2,052 lbs.

30. Adequate Not Adequate

- | | | |
|----|----------|---------------|
| a. | <u>X</u> | <u> </u> |
| b. | <u>X</u> | <u> </u> |
| c. | <u>X</u> | <u> </u> |

31. c
32. e
33. d
34. 017
35. 1.1

I. Answers to Evaluation

1. a
2. c
3. d
4. d
5. d

6. The steps in putting together a grassland management plan are as follows.

- Acquire an aerial photograph of the grassland and outline the fields included in the plan.
- Complete soil tests for each field.
- Conduct a complete pasture inventory to determine the quality and quantity of pasture available and assist in calculating stocking rates.
- Consider wildlife needs.
- Select a grassland management plan, choosing a grazing system and deciding what areas should be grazed and what fields should be mechanically harvested.

7. The following information is included in each of the components of a grassland management plan.

- a) Soil test results - analysis of soil fertility
- b) Soil identification - information on the type of soil and drainage and use classification
- c) Maps - visual representation of the land; includes types of soil and physical layout
- d) Plant composition - quality, quantity, and variety of plants in a plot
- e) Livestock needs - nutritional needs based on species, age, sex, production level, and environment
- f) Herd inventory - the quantity of animals within each classification

8. Overseeding involves broadcasting legumes into an existing pasture in which the stand is thinned or grazed close to the ground.

UNIT III - GRASSLAND MANAGEMENT PRACTICES

Name _____

Lesson 5: Grassland Management Plan

Date _____

EVALUATION

Circle the letter that corresponds to the best answer.

1. One of the greatest benefits of no-till drilling is:
 - a. Reduction in soil erosion.
 - b. Lower seeding rates.
 - c. Precise placement of seed.
 - d. Reduction in the loss of organic matter.
2. Which factor should be considered first in forage selection?
 - a. Livestock management
 - b. Grazing management
 - c. Forage management
 - d. Forage and livestock management
3. For what type of plants is prescribed burning most often used?
 - a. Legumes
 - b. Cool-season grasses
 - c. Nonnative warm-season grasses
 - d. Native warm-season grasses
4. Which of the following is not considered when selecting a grazing system?
 - a. Herd needs
 - b. Wildlife
 - c. Resources
 - d. Liming
5. Part of the livestock management component of selecting a forage is _____.
 - a. Climate
 - b. Condition of the grassland
 - c. Nutrient content
 - d. Intensity of harvest or grazing

Complete the following short answer questions.

6. What are the steps in putting together a grassland management plan?

7. What information is included in each of the following components used in putting together a grassland management plan?
- a. Soil test results
 - b. Soil identification
 - c. Plant composition
 - d. Maps
 - e. Livestock needs
 - f. Herd inventory
8. How is overseeding with legumes done?

Determining Grassland Condition

Objective: To determine the condition of a grassland.

This activity sheet was designed for use by persons with different levels of technical ability. It can be used to visually estimate the condition of grassland quickly and without tools. It guides the user to evaluate ten items important to grassland condition. With experience, condition surveys will be quite consistent between users.

Use this form to inventory up to five different fields or sites. Enter the grassland group for the site being evaluated. Acres can be the total acres in the field or the acres represented by the evaluation. The month and year should be recorded in the appropriate row. When it asks for a percent, the user should make his or her best visual estimate. After assigning a value for each category, total the values for the grassland and use the scale at the bottom of the table to rate the condition of the pasture. Where needed, use weighted values and interpolate. For example; if you cannot decide between a value of 2 or 3, use a value of 2.5.

CATEGORY:

1. Plant Population - Visually estimate the percent composition by weight of each plant grouping and assign a weighted value. What is considered desirable, intermediate, and undesirable will vary with the site, kind of grazing animal, and intended use.
2. Plant Diversity - Diversity is the number of different kinds of plants that are well represented on the site. If only one kind of plant occurs, diversity is narrow; if eight or more kinds are present, diversity is broad.
3. Plant Density - Ignore undesirables and visually estimate the density of living desirable and intermediate species that would be present in a two-inch stubble. Is there room for more desirable and intermediate plants?
4. Plant Vigor - Are the desirable and intermediate species healthy and growing at their potential? Some things to look for are color, leaf area index, reproduction, presence of weeds, rate of growth and regrowth, etc.
5. Legumes in Stand - Visually estimate the percent composition by weight of the legumes in the stand for the area being evaluated.
6. Severity of Use - Close and frequent use causes loss of vigor, reduces desirable species, and promotes erosion and runoff. Light use allows excessive residue buildup, blocks sunlight, and reduces palatability and production.
7. Uniformity of Use - In uniform grazing, most plants are grazed to a moderate, uniform height throughout the field. Spot grazing appears uneven, with some plants or parts of the field grazed heavily and others lightly.
8. Soil Erosion - Visually observe and collectively evaluate all types of erosion and determine the severity for the area being surveyed.
9. Woody Canopy - Estimate the percent canopy (shaded area at noon) of woody cover over six feet tall.
10. Plant Residue - Appropriate residue provides adequate ground cover to retard runoff, improve water intake, return nutrients to the soil surface, and provide a favorable microclimate for biological activity.

1/4 Sec.	Tn.	Range	Field#:					
Grassland Group:								
Acres:								
Month and Year:				M Y	M Y	M Y	M Y	M Y
CATEGORY	PARAMETER / VALUE			VALUE	VALUE	VALUE	VALUE	VALUE
1) Plant Population - The estimated % by weight is mostly:	desirable	3	4					
	intermediate	2						
	undesirable	1	0					
2) Plant Diversity - The diversity of plant species is:	broad > 7	3	4					
	medium 4-5	2						
	narrow < 2	1	0					
3) Plant Density - Desirables and intermediates are:	dense >95%	3	4					
	medium 75-85%	2						
	sparse <65%	1	0					
4) Plant Vigor - Desirables and intermediates are:	strong	3	4					
	medium	2						
	weak	1	0					
5) Legumes in Stand - Percent of legumes by weight make up:	>40%	3	4					
	20-29% 30-39%	2						
	<10% 10-19%	1	0					
6) Severity of Use - The degree and frequency of use is:	light	2	0					
	moderate	4						
	heavy	2	0					
7) Uniformity of Use - The uniformity of grazing use is:	uniform	3	4					
	intermediate	2						
	spotty	1	0					
8) Soil Erosion - Sheet, rill, gully and stream bank erosion are:	slight	3	4					
	moderate	2						
	severe	1	0					
9) Woody Canopy - The canopy over 6 feet makes up:	<11%	3	4					
	21-30% 11-20%	2						
	>40% 31-40%	1	0					
10) Plant Residue - Dead and decaying plant materials is:	excessive	2	0					
	appropriate	4						
	deficient	2	0					
TOTALS								
PASTURE CONDITION								
0-10 = VERY POOR		11-20 = POOR		21-30 = GOOD		31-40 = VERY GOOD		

Lesson 5: Grassland Management Plan

Name _____

Evaluating a Grassland**Objective:** Evaluate a grassland and make suggestions to improve productivity.

Read the following scenario and use the information provided to answer the questions. This information should allow you to make recommendations about how to alter management practices to improve productivity. Round all calculations to the nearest pound.

A producer near Springfield, Missouri, has a cow/calf operation. The herd includes sixty cows with an average weight of 1,100 pounds each. The cows have superior milking ability. There are two bulls with an average weight of 1,800 pounds each. The producer's calving and breeding season is concentrated in summer. The producer has a problem with low conception rates, which results in a poor calf crop (65 percent). The producer uses continuous grazing management. The limestone dealer guarantees 400 pounds of effective neutralizing material per ton of agricultural limestone.

Forage Production (for the entire farm):

<u>Pasture</u>	<u>Acres</u>	<u>Production</u>	<u>Distribution</u>	<u>Lbs. of dry matter available</u>		
				<u>Spring</u>	<u>Summer</u>	<u>Fall</u>
Fescue/ clover	40	3.5 T	.6, .2, .2	168,000	56,000	56,000
Orchardgrass/ lespedeza	50	3 T	.5, .3, .2	150,000	90,000	60,000
Caucasian bluestem	60	4 T	0, .7, .3	0	336,000	144,000
Alfalfa/ orchardgrass	40	4 T	.5, .3, .2	160,000	96,000	64,000
Stockpiled fescue	60	3 T	.5, .1, .4	180,000	36,000	144,000
Wheat	50	4 T	.6, 0, .4	240,000	0	160,000
Total	300			898,000	614,000	628,000

Description of the Grassland:

The pasture is surrounded by fence. Visual estimates indicate that the pasture is approximately 55 percent fescue, 20 percent white clover, 15 percent red clover, and 10 percent orchardgrass. The cattle have generally grazed the plants in the entire pasture to the same height over the entire field, leaving about five inches of growth. The growth is thick and vigorous. The forage in the grassland is leafy and not producing seeds. The pasture is largely clear of weeds and brush, with only a very small amount of cover vegetation. The nearest crop field is 600 feet away, and the nearest wooded area is almost that far.

University Extension
University of Missouri - Columbia

Date: 5/1/97
Serial No. 9999
Lab No. G9000

University Extension

Soil Test Recommendations

For: MO Grassland Contest Example

Field ID: Hilltop Sample No. 1
Acres 20
Limed: unknown Not irrigated

SOIL TEST INFORMATION Delta Lab Portageville		Ratings Verylow Low Medium High Veryhigh Excess					
pHs	5.5	*****					
Phosphorus	18 Lbs/a P	*****					
Potassium	210 Lbs/a K	*****					
Calcium	1035 Lbs/a Ca	*****					
Magnesium	350 Lbs/a Mg	*****					
O. matter	2.2 %	N. Acidity		1.5 meq/100g	C.E.C.		5.8 meq/100g
NUTRIENT REQUIREMENTS (Lbs/a)							LIMESTONE suggestions
Cropping options		Yield	N	P2O5	K2O	Zn	S
004 COOL SEASON GRASS EST			30	55	0		
007 WARM SEASON GRASS EST			0	35	0		
019 COOL SEASON GR PAST		150 CD/A	90	35	20		
027 WARM SEASON GR PAST		150 CD/A	60	20	20		
							ENM 245
							EMG 0

Some herbicide labels list restrictions based on soil pH in water. Your sample has an estimated pH in water of 6.0. Use this value as a guide to the label. If you wish to have soil pH in water analyzed, contact your dealer or local Extension specialist listed below.

To determine limestone needed in tons/acre, divide your ENM requirement by the guarantee of your limestone dealer.

For COOL SEASON GRASS EST apply 245 lbs ENM

For WARM SEASON GRASS EST apply 245 lbs ENM

Soils testing high in P or K should be retested annually to determine when maintenance fertilizer should be applied.

When N requirement for cool season grass exceeds 90 pounds per acre apply two-thirds in the period December through February and the remainder in August.

For warm season grass production, apply 60 lbs nitrogen per acre in early June.

Limestone Dealer Guarantee = 400 lbs. ENM per ton

Area Specialist:
FARMER COPY

University Extension
University of Missouri - Columbia

Date: 5/1/97
Serial No. 9999
Lab No. G9000

University Extension

Soil Test Recommendations

For: MO Grassland Contest Example

Field ID: Hilltop Sample No. 1
Acres 20
Limed: unknown Not irrigated

SOIL TEST INFORMATION Delta Lab Portageville		Ratings					
		Verylow	Low	Medium	High	Veryhigh	Excess
pHs	5.5	*****					
Phosphorus	18 Lbs/a P	*****					
Potassium	210 Lbs/a K	*****					
Calcium	1035 Lbs/a Ca	*****					
Magnesium	350 Lbs/a Mg	*****					
O. matter	2.2 %	N. Acidity		1.5 meq/100g		C.E.C. 5.8 meq/100g	
NUTRIENT REQUIREMENTS (Lbs/a)							LIMESTONE suggestions
Cropping options	Yield	N	P2O5	K2O	Zn	S	
006 OVERSEEDING LEGUMES		0	55	0			ENM 440
003 CLOVER, CLOV-GRASS EST		20	55	0			
017 CLOVER, CL-GRASS PAST 150 CD/A		0	35	20			EMG 0

Some herbicide labels list restrictions based on soil pH in water. Your sample has an estimated pH in water of 6.0. Use this value as a guide to the label. If you wish to have soil pH in water analyzed, contact your dealer or local Extension specialist listed below.

To determine limestone needed in tons/acre, divide your ENM requirement by the guarantee of your limestone dealer.

For OVERSEEDING LEGUMES apply 440 lbs ENM

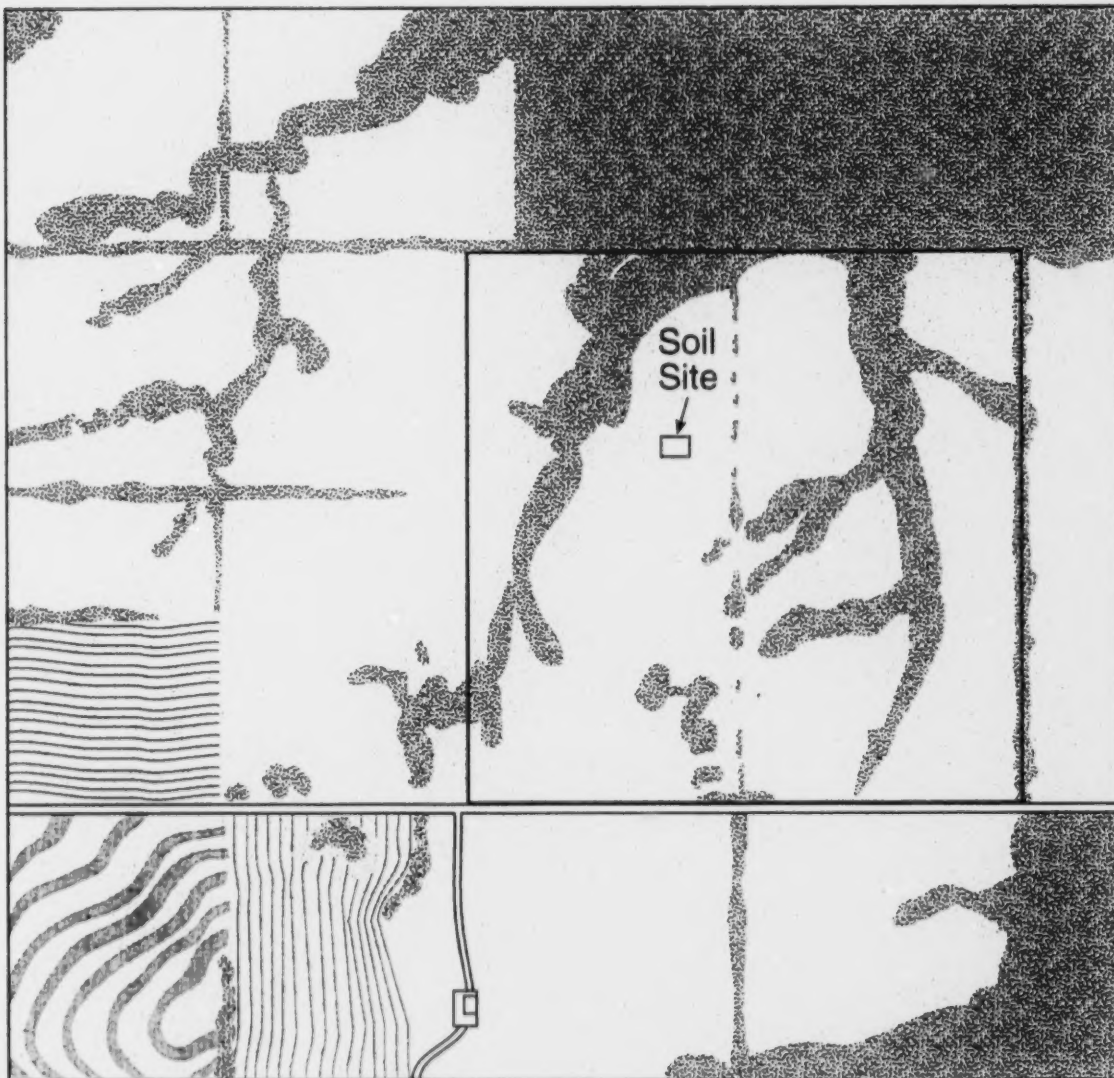
For CLOVER/CLOVER-GRASS EST apply 440 lbs ENM

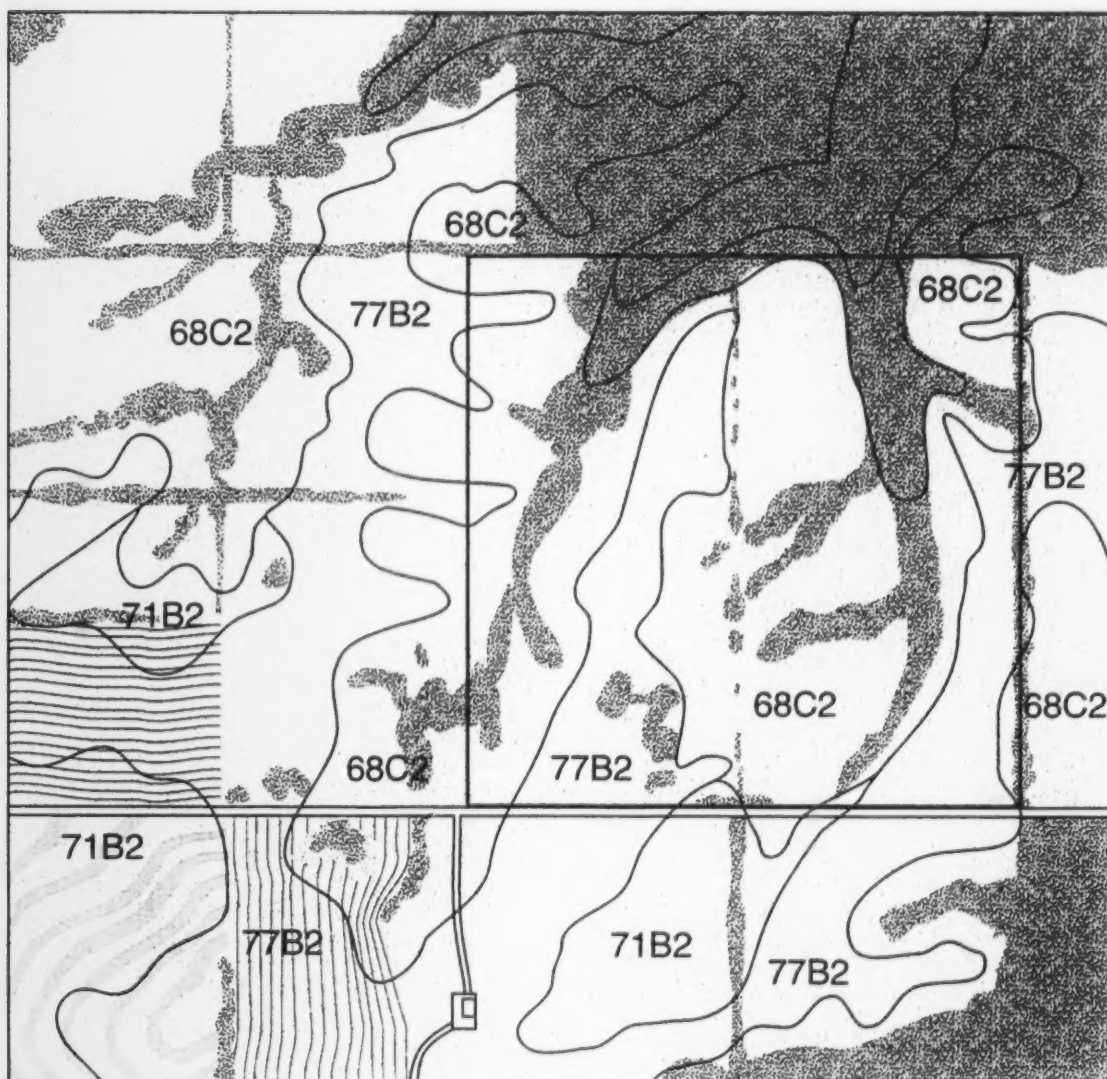
Soils testing high in P or K should be retested annually to determine when maintenance fertilizer should be applied.

Do not use nitrogen on spring seedings of legumes after May 1st, because of potential weed competition.

Limestone Dealer Guarantee = 400 lbs. ENM per ton

Area Specialist: _____
FARMER COPY





Moniteau Series**Soil Map Unit 38**

Depth class: Very deep
Position on the landform: High
Slope range: 0 to 2 percent

Drainage class: Poorly drained
Parent material: Loess and stream alluvium
Land Capability Classification: 4W

Landform: Flood plains
Permeability: Moderately slow

Soil Depths (Inches)	Available Water Capacity (In/in range)	Permeability (In/hr range)
0-7	0.21-0.23	0.60-2.0
7-14	0.20-0.22	0.60-2.0
14-67	0.18-0.20	0.20-0.6

Taxonomic class: Fine-silty, mixed, mesic Typic Endoaqualfs

Typical Pedon

Moniteau silt loam, occasionally flooded, 200 feet north and 300 feet west of the southeast corner of sec. 29, T. 49 N., R. 11 W; Millersburg quadrangle lat. 38 degrees 59 minutes 34 seconds N. and long. 92 degrees 10 minutes 7 seconds W.

Ap=0 to 7 inches; brown (10YR 4/3) silt loam, with common fine faint dark grayish brown (10YR 4/2) mottles, and few fine distinct mottles in pores; weak fine granular and weak very fine subangular blocky structure; friable; many very fine roots; strongly acid; abrupt smooth boundary.

Ex=7 to 14 inches; light brownish gray (10YR 6/2) silt loam; weak fine platy structure parting to moderate very fine subangular blocky; brittle; firm; few fine iron and manganese concretions; few very fine roots; very strongly acid; clear smooth boundary.

Btg1=14 to 32 inches; dark grayish brown (10YR 4/2) silty clay loam, with very dark grayish brown (10YR 3/2) faces of peds, and few medium faint brown (10YR 4/3) mottles; weak fine prismatic structure parting to moderate fine subangular blocky; firm; few faint and few distinct clay films; few silt coats; few very fine roots; very strongly acid; gradual smooth boundary.

Btg2=32 to 51 inches; mixed dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) silt loam, with few vertical very dark grayish brown (10YR 3/2) faces of peds, and few fine faint brown (10YR 4/3) mottles; weak fine prismatic structure parting to moderate fine subangular blocky; firm; common distinct and few faint clay films; common silt coats; few very fine roots; very strongly acid; gradual smooth boundary.

Btg3=51 to 67 inches; mixed dark grayish brown (10YR 4/2), grayish brown (10YR 5/2), and brown (10YR 4/3) silt loam; weak fine prismatic structure parting to weak fine subangular blocky structure; firm; common faint and distinct clay films; few faint silt coats; few very fine roots; very strongly acid.

Range in Characteristics

Depth to the base of the argillic horizon ranges from 36 to 60 inches or more. The particle-size control section averages between 27 and 35 percent clay and 5 to 15 percent fine sand or coarser. The base of the albic horizon is less than 24 inches.

Drainage and Permeability

Poorly drained. Runoff is slow. Permeability is moderately slow. In undisturbed areas, there is an apparent water table that has an upper limit of 0.0 to 1.0 foot during November to May in most years.

Use and Vegetation

Most areas are used for cultivated crops or pasture. Native vegetation is mixed hardwoods.

Keswick Series**Soil Map Unit 68C2***Depth class:* Very deep*Drainage class:* Moderately well drained*Landform:* Uplands*Position on the landform:* Side slope*Parent material:* Loess and underlying glacial till*Permeability:* Slow*Slope range:* 5 to 9 percent*Land Capability Classification:* 3E

Soil Depths (Inches)	Available Water Capacity (In/in range)	Permeability (In/hr range)
0-7	0.17-0.22	0.60-2.0
7-32	0.11-0.15	0.60-0.2
32-60	0.12-0.16	0.20-0.6

Taxonomic class: Fine, montmorillonitic, mesic Aquertic Chromic Hapludalfs**Typical Pedon**

Keswick silt loam, 5 to 9 percent slopes, eroded, 1400 feet east and 1600 feet south of the northwest corner of sec. 27, T. 49 N., R. 11 W; Hallsville quadrangle lat. 39 degrees 0 minutes 11 seconds N. and long. 92 degrees 8 minutes 10 seconds W.

Ap=0 to 7 inches; brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; few masses of Bt1 in lower part; moderate medium subangular blocky structure parting to moderate fine subangular blocky; friable; many fine roots; strongly acid; clear smooth boundary.

2Bt1=7 to 13 inches; strong brown (7.5YR 5/6) clay; many medium prominent red (2.5YR 4/6) iron masses; moderate medium subangular blocky structure parting to moderate fine subangular blocky; firm; common faint clay films on faces of peds; common fine roots; common fine and medium sand grains; very strongly acid; clear smooth boundary.

2Bt2=13 to 20 inches; brown (7.5YR 5/4) clay; many medium prominent red (2.5YR 4/6) iron masses; common fine distinct light brownish gray (10YR 6/2) iron depletions; moderate medium subangular blocky structure parting to moderate fine subangular blocky; firm; common faint clay films on faces of peds; common fine roots; common fine and medium sand grains; very strongly acid; clear smooth boundary.

2Btg1=20 to 32 inches; grayish brown (10YR 5/2) clay loam, many medium prominent strong brown (7.5YR 5/6) and common medium prominent yellowish red (5YR 5/6) iron masses; weak medium prismatic structure parting to moderate medium subangular blocky; firm; common faint clay films on faces of peds, few very fine roots; common fine sand grains; very strongly acid; gradual smooth boundary.

2Btg2=32 to 44 inches; gray (10YR 5/1) clay loam, common medium prominent strong brown (7.5YR 5/6) iron masses; weak medium prismatic structure parting to weak medium subangular blocky; firm; common faint clay films on faces of peds, few very fine roots; common fine sand grains; very strongly acid; diffuse boundary.

2Btg3=44 to 60 inches; grayish brown (2.5YR 5/2), clay loam, common medium prominent strong brown (7.5YR 5/6) iron masses; weak medium prismatic structure parting to weak medium subangular blocky; very firm; few faint clay films on faces of peds; common fine sand grains; very strongly acid.

Range in Characteristics

Masses of soft calcium carbonate are typically deeper than 48 inches. Typically, a pebble band is above a depth of 10 to 20 inches.

Drainage and Permeability

Moderately well drained. Runoff is medium to rapid. Permeability is slow. Where more permeable soils formed in loess are upslope, Keswick soils commonly have seepy spots in wet seasons; but in years of average rainfall this is not a hazard to use of the soil.

Use and Vegetation

Most areas are pasture or open woods. Some areas are used for cropland. Corn, oats and meadows are grown. Native vegetation is deciduous trees.

Leonard Series**Soil Map Unit 71B2***Depth class:* Very deep*Parent material:* Loess & underlying glacial till or pedisegment*Drainage class:* Poorly drained*Landform:* Uplands*Position on the landform:* Side slopes & heads of drainageways*Permeability:* Slow*Slope range:* 2 to 6 percent*Land Capability Classification:* 3E

Soil Depths (Inches)	Available Water Capacity (In/in range)	Permeability (In/hr range)
0-7	0.22-0.24	0.60-2.0
7-12	0.11-0.13	0.06-0.2
12-40	0.10-0.12	0.06-0.2
40-78	0.11-0.14	0.06-0.2

Taxonomic class: Fine, montmorillonitic, mesic Vertic Epiaqualfs**Typical Pedon**

Leonard silty clay loam, 2 to 6 percent slopes, eroded, 2650 feet east and 1600 feet north of the southwest corner of sec. 4, T. 51 N., R. 11 W

Ap=0 to 7 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; common very fine roots; neutral; abrupt smooth boundary.

Btg1=7 to 12 inches; dark gray (10YR 4/1) silty clay; few fine prominent yellowish red (5YR 4/6) and common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; few very fine roots; common distinct clay films on faces of peds; very strongly acid; clear smooth boundary.

Btg2=12 to 20 inches; dark gray (10YR 4/1) silty clay; many fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; firm; few very fine roots; many distinct clay films on faces of peds; very strongly acid; gradual smooth boundary.

Btg3=20 to 26 inches; gray (10YR 5/1) silty clay loam, few fine prominent yellowish red (5YR 5/6) and many fine prominent strong brown (7.5YR 4/6) mottles; weak fine subangular blocky structure; firm; few very fine roots; many distinct clay films on faces of peds; strongly acid; clear smooth boundary.

2Btg4=26 to 40 inches; gray (10YR 5/1) silty clay loam, few fine prominent yellowish red (5YR 4/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; firm; 15.0 percent sand; many distinct clay films on faces of peds, strongly acid; clear smooth boundary.

2Btg5=40 to 78 inches; gray (10YR 5/1), silty clay loam, common fine prominent strong brown (7.5YR 4/6) mottles; weak medium prismatic structure parting to weak fine subangular blocky; firm; 15.0 percent sand; few faint clay films in root channels and few iron-manganese stains; strongly acid.

Range in Characteristics

Depth to the paleosol is 12 to 30 inches. The lower part of the solum has about 10 percent or more sand. These soils have deep wide cracks during dry seasons, usually summer months.

Drainage and Permeability

Poorly drained. Runoff is medium. Permeability is slow. In undisturbed areas there is a perched water table that has an upper limit of 0.5 to 1.5 feet during November to April in most years.

Use and Vegetation

Most areas are used for cultivated crops or hay and pasture. Native vegetation is mixed trees and grasses.

Mexico Series**Soil Map Unit 77B2***Depth class:* Very deep*Drainage class:* Somewhat poorly drained*Landform:* Uplands*Position on the landform:* Broad interfluvies and divides*Parent material:* Loess and underlying pedisegment*Permeability:* Very slow*Slope range:* 1 to 3 percent*Land Capability Classification:* 3E

Soil Depths (Inches)	Available Water Capacity (In/in range)	Permeability (In/hr range)
0-9	0.22-0.24	0.60-2.0
9-14	0.12-0.16	0.20-0.6
14-25	0.08-0.12	0.00-0.06
25-43	0.12-0.16	0.06-0.2
43-79	0.12-0.18	0.00-0.06

Taxonomic class: Fine, montmorillonitic, mesic Vertic Epiaqualfs**Typical Pedon**

Mexico silt loam, 1 to 3 percent slopes, 500 feet east and 2200 feet south of the northwest corner of sec. 9, T. 49 N., R. 11 W; Hallsville quadrangle; lat. 39 degrees 2 minutes and 11 seconds N. and long. 92 degrees 9 minutes and 25 seconds W.

Ap=0 to 9 inches; very dark grayish brown (10YR 3/2) silty loam, grayish brown (10YR 5/2) dry; weak medium granular structure; very friable; many fine and very fine roots; neutral; clear smooth boundary.

BE=9 to 14 inches; grayish brown (10YR 5/2) silty clay loam; few fine prominent red (2.5YR 4/6) iron masses; moderate fine subangular blocky structure; very friable; common faint clay depletions; common fine and very fine roots; very strongly acid; clear smooth boundary.

Btg1=14 to 25 inches; dark grayish brown (10YR 4/2) silty clay; many fine prominent red (2.5YR 4/6) iron masses; moderate medium subangular blocky structure parting to moderate fine subangular blocky; firm; common faint clay films on faces of peds; few fine and common very few fine roots; very strongly acid; gradual smooth boundary.

Btg2=25 to 32 inches; grayish brown (2.5YR 5/2) silty clay; many coarse prominent strong brown (7.5YR 4/6) iron masses; moderate medium subangular blocky structure; firm; common fine iron and manganese stains; few faint clay films on faces of peds; few very fine roots; very strongly acid; gradual smooth boundary.

Btg3=32 to 43 inches; grayish brown (10YR 5/2) silty clay loam; common fine prominent strong brown (7.5YR 4/6) iron masses; moderate medium subangular blocky structure; firm; few faint clay films on faces of peds; common fine iron and manganese stains; few very fine roots; very strongly acid; clear smooth boundary.

2Btg4=43 to 79 inches; gray (10YR 5/1) silty clay loam; many fine prominent strong brown (7.5YR 4/6) iron masses; weak medium prismatic structure parting to weak medium subangular blocky; firm; few faint clay films on faces of peds; very few very fine roots; few very fine sand grains; strongly acid.

Range in Characteristics

At least one subhorizon contains more than 52 percent clay. Some pedons have 2 Btg or 2 BCg horizons. Depth to the top of the lithologic discontinuity is 30 to 60 inches.

Drainage and Permeability

Somewhat poorly drained. Runoff is medium. Permeability is very slow. In undisturbed areas, a perched water table has an upper limit of 0.0 to 1.5 feet during November to May in most years.

Use and Vegetation

Most areas are used to grow corn, soybeans, and small grains. Native vegetation is prairie grasses and mixed hardwoods.

Evaluation of Grassland Condition:

1. What is the pasture type?
 - a. Tall fescue (90% or more)
 - b. Mixed cool-season grass (10% legumes or less)
 - c. Cool-season grass dominant (10 to 25% legumes or other grasses)
 - d. Cool-season grass and legumes (26 to 60% legumes)
 - e. Legumes dominant (75% legumes or more)
 - f. Warm-season grasses dominant (other species 25% or less)
2. What is the average growth stage of the dominant forage species?
 - a. Vegetative
 - b. Boot or bud
 - c. Heading or bloom
 - d. Mature
 - e. Dormant
3. What best describes the grazing pressure and condition of the pasture?
 - a. Overgrazed
 - b. Spot grazed
 - c. Evenly grazed
 - d. Undergrazed
4. Is weed or brush control needed other than by grazing or soil fertility management?
 - a. Yes
 - b. No
5. What soil pH_s is recommended for this pasture?
 - a. 4.5 - 5.0
 - b. 5.1 - 5.5
 - c. 5.6 - 6.0
 - d. 6.1 - 6.5
 - e. 6.6 - 7.0
 - f. 7.1 - 7.5
6. What fertilizer rate is recommended for this pasture? (Use the correct crop option identification number to answer this question.) _____
7. What limestone rate is recommended for this pasture in tons per acre? _____

Soil Evaluation:

Identify the soil series using the maps. Use the information provided in the series description to answer the following questions.

8. What is the surface texture?
 - a. Sand
 - b. Sandy loam
 - c. Loam or silt loam
 - d. Clay loam or silty clay loam
9. What is the chert and gravel content of the surface layer (indicated in the narrative description of the soil)?
 - a. <15% (no coarse fragment modifier such as sand, silt, or clay)
 - b. 15 - <35% cherty or gravelly
 - c. 35 - <60% very cherty or very gravelly
 - d. >60% extremely cherty or extremely gravelly
10. What is the slope? (If slope ranges do not match, use the average slope.)
 - a. 0 - <2% nearly level
 - b. 2 - <5% gently sloping
 - c. 5 - <9% sloping
 - d. 9 - <14% strongly sloping
 - e. 14 - <25% steep
 - f. >25% very steep
11. What is the depth of soil (or zone) limiting rooting depth?
 - a. 40 - 60+ inches deep or very deep
 - b. 20 - <40 inches
 - c. 10 - <20 inches shallow
 - d. 0 - <10 inches very shallow
12. What is the drainage class?
 - a. Very poorly drained
 - b. Poorly drained
 - c. Somewhat poorly drained
 - d. Moderately well drained
 - e. Well drained
 - f. Somewhat excessively drained
 - g. Excessively drained
13. What is the depth of the surface layer?
 - a. 0 - 2 inches
 - b. 3 - 6 inches
 - c. 7 - 10 inches
 - d. 10+ inches

14. What is the permeability of the most limiting layer or to 60 inches?

<u>Inches/Hour</u>	<u>Class</u>
a. <0.06	very slow
b. 0.06 - <0.2	slow
c. 0.2 - <0.6	moderately slow
d. 0.6 - <2.0	moderate
e. 2.0 - <6.0	moderately rapid
f. 6.0 - <20.0	rapid
g. >20.0	very rapid

15. What is the available water capacity to the most limiting layer or to 60 inches?

Note: To find the available water capacity, multiply the number of inches in each layer of soil by the average of the inches of available water capacity in each layer. Then find the sum of the layers or to 60 inches.

- a. 0 - <3 very low
- b. 3 - <6 low
- c. 6 - <9 moderate
- d. 9 - <12 high
- e. 12+ very high

16. What is the land capability class?

- a. Class I
- b. Class II
- c. Class III
- d. Class IV
- e. Class V
- f. Class VI
- g. Class VII
- h. Class VIII

17. What are the major factors, if any, that keep the area out of Class I?

- a. S (stoniness, shallowness, droughtiness)
- b. W (wetness and/or flooding)
- c. E (erosion)
- d. None

Forage Adaptation:

Use the chart titled "Species Compatibility to Pasture Suitability Groups, for Pasture and Hayland Planning" from the Pasture and Hayland Planting Practice section of the *NRCS Field Office Technical Guide* (available at the local NRCS office) to answer the following question. Put an "X" in the appropriate blank to indicate whether or not the forage is adapted to the soil drainage class.

18. <u>Forage</u>	<u>Adapted</u>	<u>Not Adapted</u>
a. Alfalfa	_____	_____
b. Annual lespedeza	_____	_____
c. Caucasian bluestem	_____	_____

- | | | |
|---------------------------|-------|-------|
| d. Red clover | _____ | _____ |
| e. White or ladino clover | _____ | _____ |
| f. Big bluestem | _____ | _____ |
| g. Tall fescue | _____ | _____ |
| h. Indiangrass | _____ | _____ |
| i. Orchardgrass | _____ | _____ |
| j. Switchgrass | _____ | _____ |

Wildlife Habitat Evaluation:

19. What is the extent of the border?
- No border within fenced area
 - Border along one side
 - Border along two sides
 - Border along three sides
 - Border around entire field
20. What is the percent of the field covered by winter or escape cover (including brushy draws, brush piles, fallen logs, etc.)?
- No cover is present.
 - One to 10% of the field has winter/escape cover.
 - The field is less than ten acres in size.
21. What is the percent canopy coverage of shrubs and herbaceous vegetation six to eighteen inches tall?
- Less than 25% coverage
 - 26 to 75% coverage
 - More than 76% coverage
22. What is the grazing pressure?
- Heavy
 - Moderate
 - Light
 - Rotational
23. What is the percent of the ground covered or shaded by both native and introduced legumes?
- 5% or less
 - 6 to 50%
 - 51% or more
24. What is the distance from the center of the field to the edge of the nearest crop field?
- Over 500 feet to the crop field
 - 250 to 499 feet to a chiseled or disked crop field
 - Less than 249 feet to a chiseled or disked crop field
 - 250 to 500 feet to a crop field with no fall tillage or with a crop of winter wheat
 - Less than 249 feet to a crop field with no fall tillage or with a crop of winter wheat

25. What is the field size (percentage of the field within 250 feet of dense woody cover or ungrazed woodland)?

- a. Less than 25%
- b. 26 to 50%
- c. 51 to 75%
- d. 76 to 100%

26. How would you summarize the usefulness of this pasture for wildlife?

Matching Livestock and Forage:

27. When does this livestock herd have the highest forage quality requirement?

- a. Spring
- b. Summer
- c. Fall
- d. Winter
- e. High year round

28. Does this pasture's growth cycle match the seasonal peak nutritional needs of this livestock herd under present management?

- a. Yes
- b. No

29. How many pounds of forage dry matter does this herd need to consume per day in each season?

- a. Spring _____
- b. Summer _____
- c. Fall _____

30. Is forage availability adequate for this herd in each season? (Find the seasonal dry matter intake requirements; then use the forage efficiency rates for the grazing system to find the total amount of dry matter needed.)

<u>Season</u>	<u>Adequate</u>	<u>Not Adequate</u>
a. Spring (100 days)	_____	_____
b. Summer (100 days)	_____	_____
c. Fall (100 days)	_____	_____

Pasture Improvement:

31. What changes should be made in livestock management?
- a. Continue present management
 - b. Reduce livestock numbers
 - c. Change calving season to a different time of year
 - d. Shorten the calving season to a period of less than 90 days
 - e. Provide higher quality pasture for heifers and steers
 - f. Switch to a management intensive rotational grazing system
32. What type of additional forage is needed to improve this forage program?
- a. Cool-season grass
 - b. Warm-season grass
 - c. Legumes
 - d. Grass/legume mixture
 - e. No additional forages needed - use existing pasture

Answers to questions 33, 34, and 35 are based on the answer selected for question 32.

33. How should this forage be planted?
- a. Plant on clean, firm seedbed
 - b. No-till plant in a killed sod
 - c. Overseed or interseed in a closely grazed sod
 - d. No additional forages needed - use existing pasture
34. What fertilizer rate is recommended for this forage? _____
35. What limestone rate is recommended for this forage in tons per acre? _____

GLOSSARY OF SELECTED TERMS FOR
CONSERVATION AND RESOURCE USE

A

agricultural land: All land devoted to crop or livestock production (e.g., farmsteads, drainage and irrigation ditches, ponds, cropland, and grazing land on farms).

agricultural use: The use of any tract of land for the production of animal or vegetable life; uses include the pasturing, grazing, and watering of livestock and the planting, cultivation, and harvesting of crops.

animal unit (A.U.): A measurement of livestock numbers based on the equivalent of a mature cow (approximately 1,000 pounds live weight); roughly, one cow, 1.4 yearling cattle, one horse, one mule, five sheep, five swine, or six goats.

annual food plot: A small area of land planted with a mixture of annual plants that produce an abundance of small seeds as supplemental food for wildlife during winter.

annual plant: A plant that completes its life cycle in one year or less.

association: A climax plant community identified by the combination of dominant species present. *See also climax.*

available forage: 1) Plant material that is accessible for animal consumption. 2) The standing dry matter yield of plant material in a paddock or grazing unit that can be measured from the desired grazing height.

available water: The portion of water in a soil that can be absorbed by plant roots.

B

backgrounding: Practice of raising a beef animal from weaning until it is placed in the feedlot. Backgrounding may take place either on pasture or with stored feed.

biennial plant: A plant that completes its life cycle in two years.

biomass: The amount of living matter in a given unit of the environment.

border: In wildlife management, a strip of herbaceous or woody vegetation, usually low-growing and more than five feet wide, established along the edges of fields, woodlands, or streams.

brush pile: A small stack of cut branches, shrubs, and other woody vegetation that serves as protective cover for small wild animals.

browse: The nutritious buds or tips of branches of shrubs, vines, saplings, and forbs that are eaten by "browsing" wildlife such as deer. *See also green browse.*

bunchgrass: Grasses with growth forms that are clumped or tufted rather than single-stemmed; they are sod-forming.

C

canopy: The more or less continuous cover of branches and foliage formed collectively by the crowns of adjacent trees, woody shrubs, or herbaceous plant growth that intercepts raindrops during rainfall.

carrying capacity: The maximum population that a given ecosystem can support indefinitely.

climax: The highest ecological development of a plant community capable of perpetuation under the prevailing climatic and soil conditions.

clutch: The total number of bird or reptile eggs laid in one nesting.

community: An aggregation of organisms within a specified area.

conservation: The wise use of natural resources for the greatest good for the greatest number in the long run.

conservation tillage: Any tillage sequence that reduces the loss of soil or water relative to conventional tillage; it is often a form of noninversion tillage that retains a protective mulch of crop residue on the soil surface. It involves the planting of seed into either a killed or live sod with specialized equipment.

consumable forage: The average annual dry matter forage requirements for an animal unit multiplied by the number of available animal units.

continuous grazing: The grazing by domestic livestock of a specific area throughout the grazing season; not necessarily synonymous with year-long grazing.

controlled burning: *See prescribed burning.*

cool-season plant: A plant that completes most of its growth during the cool period of the year. For example, cool-season grasses grow when the soil temperature is just above 32 degrees Fahrenheit and nearly stop growing when the soil temperature is above 78 degrees Fahrenheit.

cover: Vegetation or other material used by wild animals for nesting, rearing of young, resting, escape from predators, or protection from adverse weather conditions.

covey: A small flock or number of birds together, often functioning somewhat as a unit; the term is chiefly applied to partridges (including quail).

D

deciduous plant: A plant that sheds all its leaves every year at a certain season (usually autumn).

decreaser plant species: The plant species of the original vegetation that will generally decrease in relative amounts with continued overuse; commonly termed *decreasers*.

deferred grazing: The discontinuance of livestock grazing on an area for a specified period of time during the growing season to promote plant reproduction, establishment of new plants, or restoration of vigor by old plants.

degradation: 1) The act of wearing down by erosion, especially through stream action. 2) The act of being contaminated by salts, chemicals, or other pollutants before being returned to the environment after being used by people.

density: In biology, the number of organisms per area unit at a given time.

diversity: The variety of species within a given association of organisms. Areas of high diversity are characterized by a great variety of species; usually relatively few individuals represent any one species. Areas with low diversity are characterized by few species; often relatively large numbers of individuals represent each species. Diversity enhances ecosystem stability.

dominant species: In ecology, a species that by its activity, behavior, or number has considerable influence or control over the conditions of the existence of associated species; a species that "controls" its habitat and food web.

dry matter forage: Vegetative material suitable for forage that has been dried to remove all moisture.

E

ecology: The study of the interrelationships of organisms to one another and to their environment.

ecosystem: A contraction for "ecological system"; the interacting system of a biological community and its nonliving environment.

edge: In wildlife management, the transitional zone where one cover type ends and another begins. The zone may have considerable length but is narrower than the adjoining communities themselves. Also referred to as an *ecotone*.

edge effect: The influence of two or more adjoining communities upon the composition and density of populations within the bordering area.

endangered species: A species of native fish, wildlife, or plant threatened with extinction because its habitat is threatened with destruction, drastic modification, or severe curtailment or because of overexploitation, disease, predation, or other factors. It requires assistance for survival.

endemic: Referring to an organism or species that is restricted to a relatively small geographic area or to an unusual or rare type of habitat.

exotic: Referring to an organism or species that is not native to the region in which it is found.

F

food web: All of the interconnecting food chains in a community. Also referred to as the *food cycle*.

forage inventory: A compilation of the carrying capacity in animal units and animal unit months for all management units within a farm being evaluated. The carrying capacity of each management unit is the sum of the carrying capacities of the pasture units it contains. The carrying capacity of each management unit is determined by dividing land area by the stocking rate (AC/A.U.).

forage production: The total amount of dry matter produced per unit of area on an annual basis.

forb: 1) An herbaceous plant that is not a grass, sedge, or rush. 2) A broadleaf flowering plant.

forest: A plant association consisting predominantly of trees and other woody vegetation.

G

game animal: An animal that is sought for its fur, feathers, flesh, or trophy value and is considered to possess those sporting qualities that enhance the hunting or angling experience.

glade: Relatively small, often isolated native grasslands that occur on hilltops and south-facing slopes, where thin, dry soils and dry, harsh desertlike summer conditions harbor unique natural communities.

grass: A member of the botanical family *Gramineae*, characterized by bladelike, narrow leaves arranged on the culm (or jointed stem) in two ranks, flowers in spikelets, and seedlike fruit (e.g., wheat, oats, sorghum, fescue, big bluestem, etc.).

grassland: Land where the existing plant cover is dominated by grasses.

grazing: The process of feeding by domestic livestock or wild animals on any kind of standing vegetation except browse.

grazing capacity: The maximum stocking rate possible without causing damage to vegetation or related resources.

grazing land: Land used regularly for grazing by domestic livestock.

grazing cell: A parcel of land subdivided into paddocks and grazed rotationally.

grazing period: The length of time that livestock are present on a particular paddock during a particular grazing cycle.

grazing season: The portion of the year that livestock graze, or are permitted to graze, on a given range or pasture. Also referred to as *grazing period*.

grazing system: A type of grazing management with systematically recurring periods of grazing and deferment for two or more management units.

grazing unit: An area of rangeland or pastureland, public or private, that is grazed as an entity.

green browse: Herbaceous plants that are planted specifically for grazing or browsing by wildlife, especially geese. *See also* **browse**.

H

habitat: The environment in which the life needs of an organism, population, or community are supplied.

hayland: Land used primarily for the production of hay from long-term stands of adapted forage plants.

herb: Any flowering plant except those developing persistent woody bases and stems aboveground.

herd: A group of animals, especially cattle or big game, collectively considered as a unit.

home range: The total area covered by a wild animal engaged in feeding, breeding, resting, and seeking refuge during its life cycle.

hybrid: An organism resulting from a cross between parents of different species, subspecies, or cultivars.

I

increaser plant species: Plant species of the original plant community that generally increase in relative amounts, at least for a time, under continued use. Commonly referred to as *increasers*.

indicator plant: Any plant that by its presence, frequency, or vigor indicates any particular property of the site.

indigenous: An organism born, growing, or produced naturally in a region or country; native.

intake: The mass of forage dry matter consumed by the grazing animal per day. Usually expressed as a percentage of bodyweight or pounds per day.

interspersation: The distribution of cover types and plant species in a limited area. Refers to the degree to which environmental types are intermingled or interspersed on a landscape or the intermixing of units of different habitat types.

invader plant species: Plant species that are absent in undisturbed portions of the original plant community but will invade under disturbance or continued overuse. Also referred to as *invaders*.

K

key management species: 1) Those forage species whose use serves as an indicator of the degree of use of associated species. 2) Those species on which management of a specific unit is based.

L

landscape: 1) Usually, that portion of land or territory that the eye can comprehend in a single view, including all of its natural characteristics. 2) All the natural features, such as fields, hills, forests, and bodies of water, that distinguish one part of the earth's surface from another part.

land use plan: A composite of information, ideas, policies, programs, and activities related to existing and potential uses of land within a given area; it describes the recommended location and intensity of development for both public and private land uses (residential, commercial, industrial, recreational, and agricultural).

life cycle: The stages through which an organism passes during its existence.

limiting factor: A factor whose absence, deficiency, or excessive concentration exerts some restraining influence upon a population through incompatibility with species requirements or tolerance. The parameter or item in an animal's habitat that outweighs all others in limiting productivity.

livestock: Domestic animals produced or kept primarily for farm, ranch, or market purposes, including beef and dairy cattle, hogs, sheep, goats, and horses.

M

management-intensive grazing: Grazing management in which a grazing unit is divided into subunits (paddocks) with grazing periods typically less than five days. Usually involves an increase in stocking rates, forage utilization, and labor and results in increased production per unit area or per animal. Also referred to as *intensive grazing management*, *intensive rotational grazing*. The preferred term is "management-intensive grazing" because it is management and not necessarily grazing that is intensified.

management unit: An area of land that has distinct boundaries, usually fenced, so that it may be managed separately from other units; refers to fields, paddocks, or pastures.

monoculture: The raising of crops of a single species (i.e., growing only one species of grass in a pasture or paddock).

multiple use: The use of land for more than one purpose (e.g., grazing of livestock, wildlife production, recreation, watershed, and timber production). Multiple use does not necessarily refer to the combination of uses that will yield the highest economic return or greatest unit output.

N

native species: A species that is a part of the original fauna or flora of an area.

natural resources: The air, land, soil, water, plants, animals, minerals, sources of energy, and people upon which humans depend for their necessities, needs, and wants.

natural revegetation: The natural reestablishment of plants; the propagation of new plants over an area by natural processes.

niche: The role of an organism or population in its community; each one has a certain function in the scheme of "nature."

nitrogen fixation: The conversion of elemental nitrogen to organic combinations or to forms readily usable in biological processes. The conversion is normally carried out by bacteria living symbiotically in legumes or by free-living soil bacteria.

nitrogen-fixing plant: A plant that can assimilate and fix, with the aid of bacteria living in root nodules, the free nitrogen of the atmosphere. Legumes with the associated rhizobium bacteria in the root nodules are the most important nitrogen-fixing plants.

no-till planting: See **conservation tillage**.

nutrients: Those elements or compounds essential to the growth and development of living things, such as carbon, oxygen, nitrogen, potassium, phosphorus, etc.

O

odd area: A small area of land, such as a fence corner or an irregularly shaped area, that may be used for wildlife habitat.

optimum yield: The maximum sustained yield of any harvestable crop.

organism: Any living thing.

overgrazing: Grazing so intense that it impairs future forage production and causes deterioration through damage to plants, soil, or both.

overstocking: The placing of a number of animals on a given area that will result in overuse at the end of the planned grazing period.

P

paddock: A subdivision of land within a grazing cell; it can be temporary or permanent.

palatability: The plant characteristics or conditions that stimulate a selective response by animals.

pan: A layer of soil that is strongly compacted, hardened, or very high in clay content.

parent material: In soils, the unconsolidated, more or less chemically weathered mineral or organic matter from which the soils above it have developed by the processes of soil formation.

pasture: An area devoted to the production of introduced or native forage that is harvested by grazing. In most countries, "pasture" refers only to a planted grass sward.

pasture improvement: Any practice of grazing, burning, mowing, fertilizing, liming, seeding, scattering droppings, contour furrowing, or other methods of management designed to improve vegetation for grazing purposes.

pasture management: The application of practices to keep pasture plants growing actively over as long a period as possible so that they will provide palatable feed of high nutritive value.

perennial plant: A plant that normally lives three or more years.

permanent pasture: Grazing land occupied by perennial pasture plants, self-seeding plants, or usually both that remains unplowed for many years.

pesticide: Any substance or chemical applied to kill or control weeds, insects, algae, rodents, and other undesirable pests.

pH: A numerical measure of acidity or hydrogen ion activity. A pH value of 7.0 is neutral. Values below 7.0 are acid; pH values above 7.0 are alkaline.

photosynthesis: The manufacture by plants of carbohydrates and oxygen from carbon dioxide and water in the presence of chlorophyll, using sunlight as an energy source.

plant succession: The development of vegetation whereby an area becomes successively occupied by different plant communities, each of higher ecological order, progressing toward the "climax" vegetation. *See also climax.*

pollution: The condition caused by the presence in the environment of substances of such character, and in such quantities, that the quality of the environment is impaired or rendered offensive to life.

population: A group of organisms of the same kind.

parts per million (ppm): The ratio of the number of parts of a substance in air or a liquid to one million.

prairie: A tract of level to hilly land that is dominated by grasses and forbs, has a scarcity of shrubs, and is treeless. The natural plant community consists of various mixtures of tall-, medium-, and short-growing native species, known respectively as true prairie, mixed prairie, and shortgrass prairie.

prescribed burning: The deliberate use of fire under conditions by which the area to be burned, the intensity of heat, and the rate of spread are controlled so as to achieve predetermined, professionally recommended objectives for silviculture, wildlife management, grazing, and fire-hazard reduction. Also referred to as *controlled burning*.

primary productivity: The rate at which organic matter is stored by the photosynthetic and chemosynthetic activity of producer organisms, or autotrophs; may be measured in grams per day.

R

reproductive potential: The maximum rate of increase in numbers of individuals of a species or population under optimum conditions, in contrast to the actual reproduction obtained under existing conditions.

residual: The amount of forage remaining after a grazing period. Expressed as mass of dry matter per acre or as height from ground level. Not synonymous with residue.

residue: Dead, decaying plant material present on the soil surface.

rest period: The length of time between two consecutive grazing periods on a particular paddock.

riparian land: Land situated along the bank of a stream or other body of water.

roost: The place or the support upon which birds rest, especially at night.

root zone: The part of the soil that is penetrated, or can be penetrated, by plant roots.

rotational grazing: A system of pasture utilization in which short periods of heavy stocking are followed by periods of rest for plant recovery during the same season. *See also management-intensive grazing.*

roughage: A feed, such as hay, with high fiber content and low total digestible nutrients.

runoff: That portion of the precipitation on a drainage area that is discharged from the area in stream channels.

S

seasonal grazing: Grazing restricted to a specific season.

selective grazing: The tendency for grazing animals to graze certain plants in preference to others.

slope: The degree of deviation of a surface from the horizontal, measured in a numerical ratio, percent, or degrees. Expressed as a ratio or percentage, the first number is the vertical distance (rise), and the second is the horizontal distance (run), as 2:1 or 200 percent. Expressed in degrees, it is the angle of the slope from the horizontal plane, with a 90-degree slope being vertical and 45 degrees being a 1:1 slope.

soil: The unconsolidated mineral and organic material on the immediate surface of the earth that serves as a natural medium for the growth of plants.

soil classification: The systematic arrangement of soils into groups or categories on the basis of their characteristics.

soil loss tolerance (T): The maximum average annual soil loss (expressed in tons per acre per year) that should be permitted on a given soil.

soil survey: A general term for the systematic examination of soils in the field and in laboratories that covers their description and classification; the mapping of kinds of soil; the interpretation of soils according to their adaptability for various crops, grasses, and trees; their behavior under use or treatment for plant production or for other purposes; and their productivity under different management systems.

species: A natural population or group of populations that transmit specific characteristics from parent to offspring. They are reproductively isolated from other populations with which they might breed.

spot grazing: Uneven grazing heights of forage in a pasture or paddock due to selective grazing by livestock. It is usually due to low animal stocking rates or low animal density per paddock.

standing crop: The total biomass of an area at a given time.

stocker: A beef animal in the period between weaning and feedlot placement.

stocking rate: The number of animals, animal units, or total animal live weight assigned to a grazing unit for a fixed period of time and on a per-unit basis.

sustained yield: A condition in which the rate of utilization or consumption of a resource does not exceed the rate of recovery or production.

sward: Grass-covered soil or a mixed herbaceous plant community.

T

temporary pasture: A pasture, usually consisting of annual plants, intended to provide grazing for only a short period.

tillage: The operation of implements through the soil to prepare seedbeds and rootbeds, control unwanted vegetation, aerate the soil, and cause faster breakdown of organic matter.

transect: A cross section of an area used as a sample for recording, mapping, or studying vegetation. A transect may be a series of plots, a belt, strip, or line, depending on its purpose.

U

undergrazing: Grazing in which the available forage is not fully utilized.

V

vegetation type: A plant community with distinguishable characteristics.

W

warm-season plant: A plant that completes most of its growth during the warm period of the year, generally late spring and summer. For example, warm-season grasses start growing when the soil temperature reaches 55 degrees Fahrenheit and nearly stop growing when it reaches 90 degrees Fahrenheit.

water penetration: The depth to which irrigation water or precipitation penetrates soil before the rate of downward movement becomes negligible.

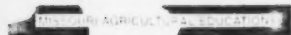
watershed: The land area that drains toward a natural surface water system.

wildlife: Undomesticated animals, considered collectively.

wildlife management: The science and art of changing the characteristics and interactions of habitats, wild animal populations, and human beings to achieve specific human goals by means of the wildlife resources.

woodland: Any land used primarily for growing trees and shrubs, compared to open land used for grazing or other agricultural purposes.

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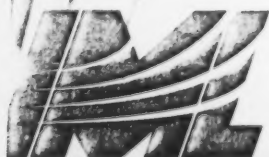
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Introduction to Grassland Management

Student Reference



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INTRODUCTION TO GRASSLAND MANAGEMENT

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FOREWORD

The development of the *Introduction to Grassland Management* curriculum guide is the result of suggestions by the MVATA Teaching Aids Committee. The Grassland Management Advisory Committee suggested the topics to be included and reviewed the materials.

This three-unit curriculum contains 11 lessons. Topics include grasslands and grassland plants, soil management, and grassland management practices. An instructor guide can be purchased separately. IML's *Crop and Grassland Plant Identification Manual* was designed to accompany the *Introduction to Grassland Management* curriculum as a reference to common species of grasses, legumes, forbs, and woody plants.

During the summer of 1981, the Missouri State Board of Education formally adopted the concept of "Instructional Management Systems" (IMS) as a priority for the 1981-82 school year. The Missouri Commissioner of Education described the IMS concept as a practical way of "organizing for excellence" in education. To meet the demand for greater productivity and accountability, the director of Vocational Education applied the elements of IMS to form the Vocational Instructional Management System (VIMS). The VIMS process provides a framework to use in planning and organizing to assure excellence in Missouri's vocational education system by focusing greater attention on the management of teaching and learning.

The instructor guide to accompany this student reference incorporates the needed component parts to aid agriculture teachers in the implementation of VIMS.

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INTRODUCTION TO GRASSLAND MANAGEMENT

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Lesson 1:

An Introduction to Grasslands

Grasslands cover much of the earth. On every continent, various types of grasslands spread over vast areas wherever environmental conditions favor these plant communities over forest and desert. Much of the best cropland, pasture, and range used for agricultural production was originally native grassland. As a natural resource, grasslands are priceless.

Grasslands play an important role in Missouri. Agriculture is Missouri's largest industry, and livestock accounts for more than half of Missouri's total agricultural production. Grasslands contribute more than half of the total amount of feed used by this industry. Besides forage for livestock, grasslands provide other benefits, including wildlife, recreation, and conservation of soil and water. The key to providing these benefits at the highest sustainable level is good management.

What is a Grassland?

Ecologically, a grassland is any plant community dominated by grasses, whether they exist naturally or because of management practices. In this sense, pastures, golf courses, and front lawns can all be considered grasslands.

Agriculturally, grasslands are areas managed to grow grass, legumes, or other pasture or range plants. Most agricultural grasslands are artificially established plant communities planted for forage production, though some are established for soil and water conservation and wildlife habitat. These uses usually can be combined successfully with proper planning.

What is a Forage?

Forages are plants, primarily grasses and legumes, grown as feed for livestock. In contrast to feed grains, the soft vegetative parts of forages--mainly the leaves and stems--become feed. Thousands of species of grasses and legumes exist worldwide, and most have value as forage. They are harvested by grazing and by mechanical mowing. While feed grain is not normally considered forage, the vegetative parts of grain plants are sometimes used as forages after harvest.

Natural Factors Affecting Grasslands

Climate, soil, plants, grazing animals, and fire all interact to determine what vegetation occupies a given area and how well it grows. Humans also have a huge impact on grasslands. By changing how these factors interact, grasslands can be improved or abused, created or destroyed. Understanding the natural system is necessary to manage grasslands for greater productivity.

Climate - Grasslands compete with other types of vegetation for growing space. They usually dominate in areas averaging 10 to 30 inches of rainfall annually. The local environment can have a great effect, however. For example, grasses may dominate in a forest region with rainfall exceeding 30 inches if other factors create a harsh environment for trees. Most of Missouri receives 35 inches or more, which is at the transition point between grassland and forest. Trees and shrubs will invade most Missouri grasslands if they are not managed properly.

Soil - Since Missouri is at a transition point between grassland and forest, soils play an important role in determining the type of vegetation found in a particular area. Some soils, such as those that do not hold moisture because they are shallow or coarsely textured or have hardpan (a dense layer of soil) close to the surface, may discourage tree growth even when enough rainfall exists. Soils with high water tables inhibiting the root systems of trees may also favor grasses.

Plants - Grasses may make up the bulk of the vegetation found in a grassland community, but a rich diversity of broadleaf plants may also be present. These plants can be nutritionally valuable for livestock. Relatively few are problem species that require control, and most of these species only become a problem in pastures that have been abused. A mixture of grasses and broadleaf plants is especially important to wildlife, which depend on them for a variety of foods and cover. Pure stands of legumes like alfalfa are sometimes planted on grasslands. They are usually used for hay or silage rationed to livestock along with other feed.

Many grassland plants have adapted to their environment by becoming dormant when conditions are harsh and producing new growth when conditions improve. Healthy plants can usually survive losing the current year's growth if allowed time to grow back. This process allows grassland

Introduction to Grassland Management

species to survive damage from fire, grazing/browsing, drought, and high winds, all of which can kill or limit the growth of trees and shrubs.

Because most forage plants are perennials, the long-term health of the plants must always be a management priority. Excessive harvesting may yield more income one year, but overusing the plants year after year will cause the grassland to deteriorate and future productivity to decline.

Grazing - Grazing is natural to grassland communities. Before European settlement in Missouri, buffalo, deer, and elk grazed and then moved on as they depleted the forage, allowing plants to grow back. Unlike trees and shrubs, which can be severely damaged by grazing and browsing, grassland plants adapted to this cycle. The adaptation of grassland plants to grazing makes forages an important part of a productive farming operation. Grassland plants can produce an abundant crop for harvest while surviving to repeat the process. With good management, this harvest and renewal can go on indefinitely.

Fire - Grassland plants tolerate fire better than trees and shrubs and often depend on fire to maintain their dominance. With their most important parts insulated underground, they are better able to recover even if fire destroys living tissue. Grasslands are so well adapted to burning, they actually create dry conditions that favor fire at just the right time. Where fire occurs often enough to limit tree growth, grasslands usually dominate. If fire is excluded and not compensated for through practices like grazing, haying, disking, seeding, or prescribed burning, grasslands deteriorate in quality and productivity and begin to be replaced by forest.

Native Grasslands

Native grasslands are those that existed in America before the arrival of European settlers. For example, the prairies of the Great Plains were originally one vast native grassland. These grasslands are sometimes called natural grasslands, but Native Americans are believed to have used fire extensively for thousands of years in ways that extended the natural range of grasslands. Therefore, human actions may have caused many of Missouri's original grasslands.

The trend toward conservation farming has led to new interest in native grasslands and their plants. Native plants and plant communities are well-

adapted to Missouri's environments. When included in a farm plan and properly managed, native species can provide forage that is nutritious and palatable. The forage may be available for grazing when traditional pasture species are dormant. They can also provide better wildlife habitat and ground cover that is more effective in building soil and conserving water.

Missouri's native grasslands include several different plant communities. Most of them are prairies, glades, or savannas.

Prairies

Prairies are large, continuous native grasslands in which trees and shrubs are nearly absent. While grasses dominate, prairies support a rich diversity of grasses, legumes, and forbs. Before European settlement, more than 250 species of native grasses, legumes, forbs, and wild flowers thrived on prairies. Wildlife depended on these plants for survival. The prairies of the Great Plains reached well into Missouri and in some areas mingled extensively with forests, depending on local conditions. Prairies originally dominated nearly 27 percent of the state.

Different kinds of prairies develop on different sites. Drier sites support shorter grass species, such as little bluestem and sideoats grama. Most of these drier prairies have been converted to pasture, and much of it is improperly grazed. Wetter sites support taller species like big bluestem and indiangrass, which can reach six feet or more in height. Most moister prairies have been converted to cropland.

Overgrazing, invasion by woody plants, and conversion to cropland and other uses have made native prairies very rare. The result has been the loss and endangerment of many species of native plants and wildlife. However, native prairies are receiving new appreciation for their plant diversity and their production of summer forage when cool-season grasses are dormant.

Glades

Glades are relatively small, isolated native grasslands that form on hilltops and southwest-facing slopes where rocky outcrops, exposure to sunlight, and thin, dry soils create harsh, desert-like conditions during the summer. Dry conditions and fire keep them mostly clear of trees. Prairie grasses

and forbs dominate, but plants and animals from western prairies and deserts like yuccas, cacti, tarantulas, and scorpions can be found.

Glades are rare environments found only in the central Midwest. They occur in prairie regions but are more obvious when found in forests. Different types of glades develop over different bedrock. Each of these communities is unique. The precise balance of environmental factors that create a glade also makes them fragile and easily disturbed by overgrazing, total exclusion of fire, and the introduction of nonnative plants.

Savanna

Savanna is a specialized community intermediate between grassland and forest with widely spaced trees, a noticeable absence of small trees and shrubs, and grasses as the main ground cover. Early settlers described parts of Missouri as park-like expanses of trees with grasses beneath them that were easily traveled on horseback. They were native savannas, once common along the edges of prairies and glades where grassland and forest met.

Savannas result from site conditions and a fire history that keeps many woody plants from reproducing while others manage to reach a size resistant to fire damage. They have become rare due to overgrazing, logging, replacement by true forest, and conversion to pasture, cropland, and other uses. If recognized and managed properly, savannas can provide wood and valuable wildlife habitat as well as forages for livestock.

Managed Grassland

Managed grassland is any area currently managed for forage, pasture, or grassland habitat. Most grassland in Missouri today can be considered managed, whether it consists of native grassland or an artificially established community. Even areas identified as "wild" grasslands must be intensively managed because human actions have altered the natural forces and cycles that created them.

More than 95 percent of grasslands in Missouri are privately owned. Most of them are used for forage; pasture is the most common type of grassland. Very little is managed as native grassland. However, because of improvements in management practices, native grasslands and pastures with native species can increase productivity.

Grassland Management and Conservation

Grassland management is the use and care of grasslands. As with any agricultural crop, grasslands must be cared for to keep them productive. Grassland management involves managing the plants, animals, equipment, and practices needed for the successful use of grasslands in an agricultural operation.

All grasslands are natural resources and require good conservation practices. Grassland conservation is the wise use of grasslands and other natural resources found on them to ensure long-term productivity and sustainability. Good management seeks to achieve the highest productivity while maintaining the system that provides it. Pushing that system beyond sustainable limits will cause the system to break down. Plants and soil will not suddenly disappear, but grasslands overgrazed or otherwise abused will decline in productivity over time. Properly managed grasslands maintain their productivity and even increase it by helping to build healthy plant communities. In addition, well-managed grasslands conserve soil, water, and wildlife.

Research and development into improved practices is a continuing effort, and grassland managers need to remain informed about new techniques that can improve their operations. Special grazing systems for livestock have been developed that protect grassland while improving production. Research is also showing how native species can increase production while protecting natural resources.

Summary

In agriculture, a grassland is an area managed to grow grass, legumes, or other pasture or range plants for forage production. Forages are primarily grasses and legumes used as feed for livestock. Several basic environmental factors--climate, soil, plants, grazing, and fire--influence the growth of grasslands. Native grasslands, including prairies, glades, and savannas, once covered much of the state, but most have been converted to other uses. Most of Missouri's grasslands now consist of pastures of nonnative plants, although native grasslands and native plants are showing new promise in livestock operations. The key to success in grassland farming is proper management, which focuses on sustaining the productivity of forage plants.

Introduction to Grassland Management

Credits

Castilon, David A. *Soil Formation and Distribution in Missouri*. Jefferson City: Missouri Department of Conservation, 1984.

Castilon, David A., and Jack C. Woodhead. *Biogeography of Missouri*. Jefferson City: Missouri Department of Conservation, 1991.

Heath, Maurice E., et al. *Forages*. Ames: Iowa State University Press, 1974.

Nelson, Paul W. *The Terrestrial Natural Communities of Missouri*. Jefferson City: Missouri Department of Natural Resources, 1985.

Odum, Eugene P. *Fundamentals of Ecology*. Philadelphia: W. B. Saunders Publishing, 1971.

Schroeder, Walter A. *Presettlement Prairie of Missouri*. Jefferson City: Missouri Department of Conservation, 1982.

Woodhead, Jack C. *Prairie Life of Missouri*. Jefferson City: Missouri Department of Conservation, 1991.

Grasslands and Grassland Plants

Lesson 2: Plant Classification

Grasslands are useful due in part to the wide variety of plants that are found in them. The main feature of grassland agriculture is its dependence on grassland plants. By understanding the different plant types, increasing the benefits to livestock and wildlife from the grassland is possible. A thorough knowledge of the various types and life cycles of these plants is important to grassland management.

Grassland Plant Classification

A grassland may include a great variety of different plant species. All grassland plants can be classified according to two different criteria--life cycle and plant type.

Classification by life cycle divides plants based on their yearly growth and seeding characteristics. Each plant grows in stages which, from beginning to end, comprise its life cycle. A plant's life cycle is closely related to its productivity and is therefore extremely important. Plants can be divided by their life cycles into three categories: annuals, biennials, and perennials.

Annual plants complete their life cycle within one year or growing season. They die after producing seed and will not grow again the next year unless self-seeded or planted again. Corn, cheat, and crabgrass are examples of annual plants.

Biennial plants require two years to complete their life cycle. Generally, the plant produces mainly vegetative growth, including leaves, stems, and roots, in the first year after germination. The plant produces flowers, fruits, and seeds the second year. At the end of the second year, the plant dies. Red clover is an example of a biennial plant.

Perennial plants grow year after year. Perennials produce flowers, fruit, and seeds each year. After they produce seeds, they go into a resting period called dormancy. This process is more noticeable in regions that have cold winter seasons, where perennials may stop growing completely for the winter. During the period of dormancy, the perennial slows down all its natural processes to protect itself from colder temperatures. When spring comes, its pattern of growth begins again.

Many forages and pasture crops are perennials. Trees and shrubs are also perennials.

In classification by plant type, plants are categorized according to the physical characteristics of the plant. Each species within a plant type has characteristics that are similar to all other species of the same plant type. Four different plant types are found in grasslands--grasses, legumes, forbs, and woody plants.

Grasses of the Grassland

Grasses are one of the four dominant plant types found in a grassland. They serve many purposes, such as food for livestock and wildlife (orchardgrass, fescue, and alfalfa), food for humans (cereals and grain sorghum), and erosion prevention.

The grasses of the Great Plains are herbaceous, or without woody stems. The stems, or culms, of grasses are usually hollow and therefore resist compaction. Leaves or blades connect directly to the culm at a sheath, which surrounds the stem. All leaf blades have a distinctive parallel venation, in which the veins run side by side along the length of the blade of grass. These visual characteristics make it possible to separate the grasses from all other plant species. Notice the characteristics of the grasses pictured in Figure 2.1.

The two major groups of grasses are cool-season and warm-season grasses. Cool-season grasses tend to grow best during the spring and fall. These plants begin their growing season when the soil temperature reaches 40° F, but optimum growth occurs when air temperatures fall in the 59 to 77° F range. They may remain green all winter, but during the summer months they tend to become brown and dormant. They may be annuals or perennials.

Figure 2.1 - Characteristic Grasses: Indiangrass, Orchardgrass, Switchgrass



Introduction to Grassland Management

Examples of cool-season grasses include Kentucky bluegrass, orchardgrass, and smooth brome grass.

Warm-season grasses are just the opposite, in that they grow best during periods of warm temperatures. These grasses are much more tolerant of heat and drought than cool-season grasses. Their growing season begins when soil temperature reaches 60°F, and they grow best during the summer when temperatures are in the 77 to 104°F range. They are dormant in the winter and do not begin to turn green until early summer. They also may be annuals or perennials. Some examples of warm-season grasses are indiangrass, big bluestem, and switchgrass.

Missouri has the right climate and amount of annual rainfall for both cool-season and warm-season grasses. Figure 2.2 shows how the growth periods of these two grass types complement each other and extend the length of green pasture production in Missouri.

Legumes

Legumes and grasses together make up the dominant plant types found in grasslands. Both are used as forage crops and therefore are beneficial to agricultural production. Figure 2.3 shows characteristic legumes. Examples of legumes include soybeans, alfalfa, clovers, and birdsfoot trefoil.

Legumes have several identifying characteristics. One characteristic of legumes is the fruit or pod that they produce. This pod has one chamber, with seeds lined in a single row. The seed number and size varies for different plants. All legumes have leaves that are alternate in arrangement on the stem and are connected to the stem by a stalk called a petiole. Unlike the grasses, venation in a legume consists of a network of veins rather than veins that run parallel to each other. Legumes may be annuals, perennials, or biennials.

Figure 2.2 - Cool- and Warm-Season Grass Growth

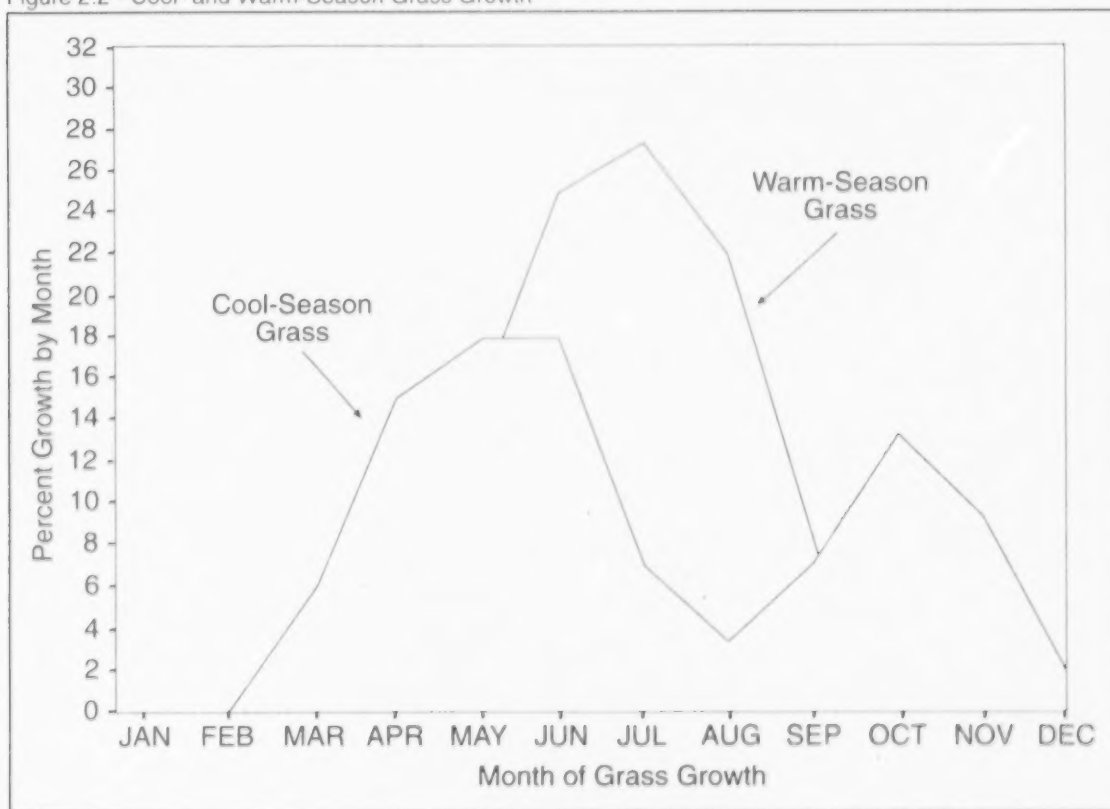
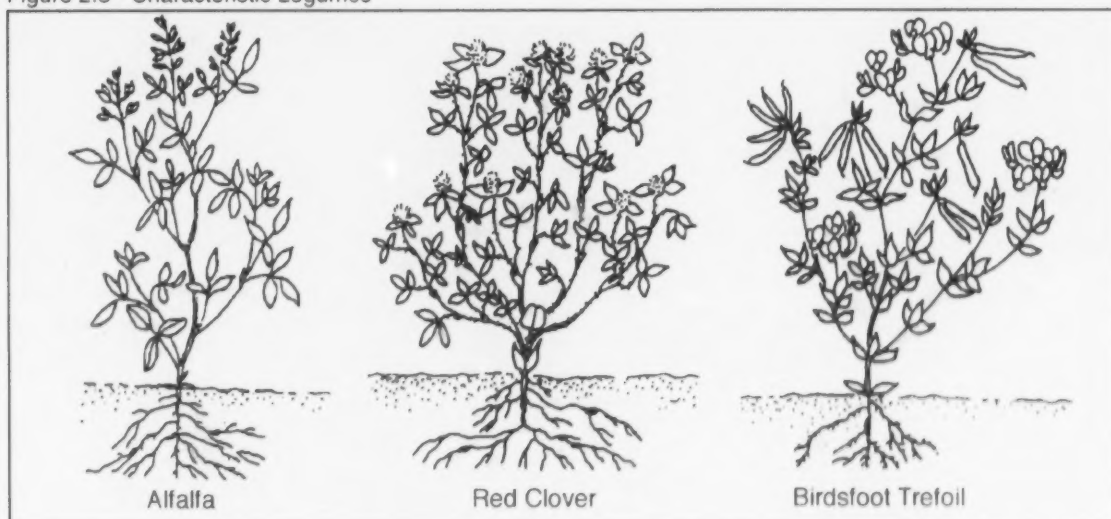


Figure 2.3 - Characteristic Legumes



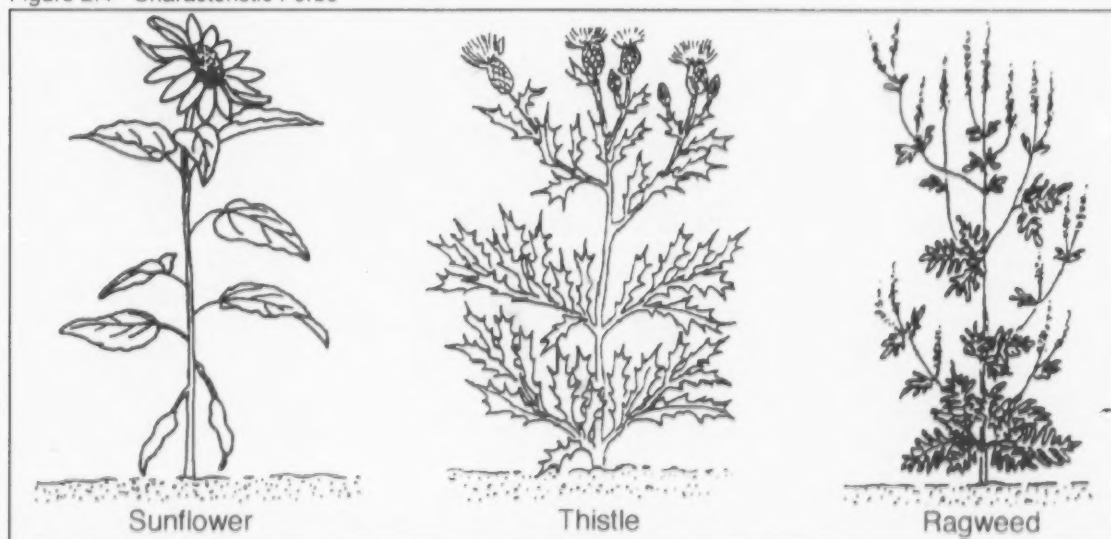
Most legumes have the unique ability to take nitrogen from the air between soil particles and change it into a form of nitrogen that plants can use. This process is known as nitrogen fixation and is carried out by symbiotic bacteria found in nodules on the roots. This nitrogen helps decrease fertilizer needs, reduce costs, increase yields, and enrich the soil.

Forbs

Herbaceous (or not woody) plants that are neither grasses or legumes are called forbs. Most forbs are

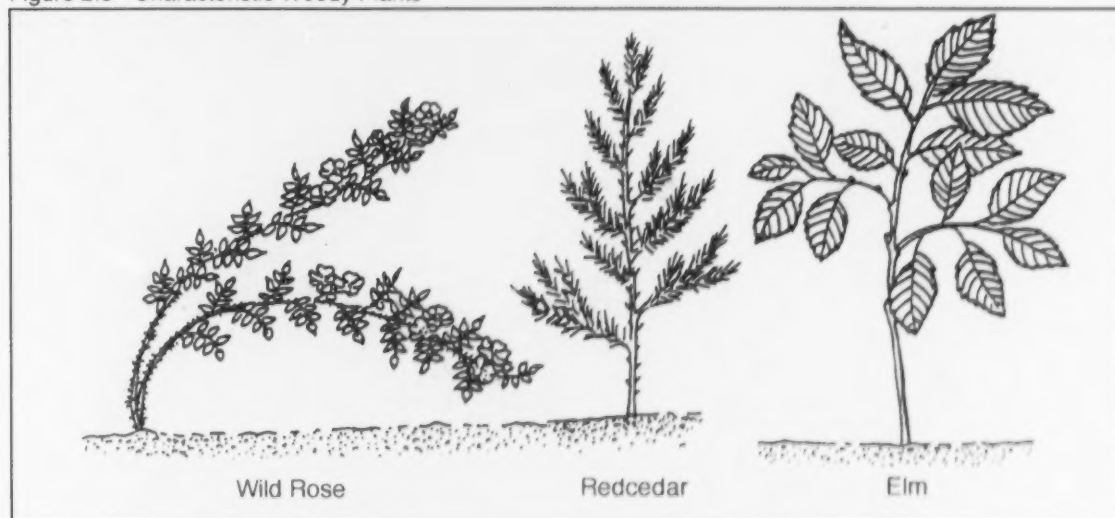
broad-leaved, making it possible to distinguish them from grasses or grasslike plants. Forbs are not usually cultivated for agricultural production, but they commonly appear in both pastures and native plant habitats. Many forbs have value as wildlife food and cover or for prevention of soil erosion. Others are considered to be noxious weeds. Forbs may be annuals, perennials, or biennials. Some examples of forbs are sunflowers, thistle, and ragweed, which are pictured in Figure 2.4.

Figure 2.4 - Characteristic Forbs



Introduction to Grassland Management

Figure 2.5 - Characteristic Woody Plants



Woody Plants

Woody plants are probably the easiest plants to identify in the grassland because of their tough, woody (nonherbaceous) stems. They are either shrubs, vines, or trees. Woody trees found in grasslands are almost always immature due to the nature and use of the grassland. They are kept small by animals that graze on terminal branches, by fires that stunt growth, by mechanical cutting, or by chemical treatments carried out to maintain the grassland. Woody plants are perennials. Examples of woody plants found in grasslands include wild rose, redcedar, and elm, shown in Figure 2.5.

Summary

Understanding plant types and life cycles will help in managing a grassland for many purposes. Grassland plants may be annuals, biennials, or perennials; they may also be grasses, legumes, forbs, or woody plants. They are important for the whole grassland habitat and its many uses.

Credits

Barnes, Robert F., Darrell A. Miller, and C. Jerry Nelson. *Forages, Volume I: An Introduction to Grassland Agriculture*. 5th ed. Ames: Iowa State University Press, 1995.

Coambes, Howard, John Jennings, and David E. Pitts. *Grassland Evaluation Contest Study Guide*.

University of Missouri-Columbia: Instructional Materials Laboratory, 1998.

Hitchcock, A. S. *Manual of the Grasses of the United States*. 2nd ed. 2 vols. New York: Dover Publications, Inc., 1971.

Humphrey, John Kevin. *Plant Science*. University of Missouri-Columbia: Instructional Materials Laboratory, 1991.

Rodekohr, Sherie, and Debi Waeckerle. *Landscaping and Turf Management*. University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

Lesson 3:
Botanical Characteristics

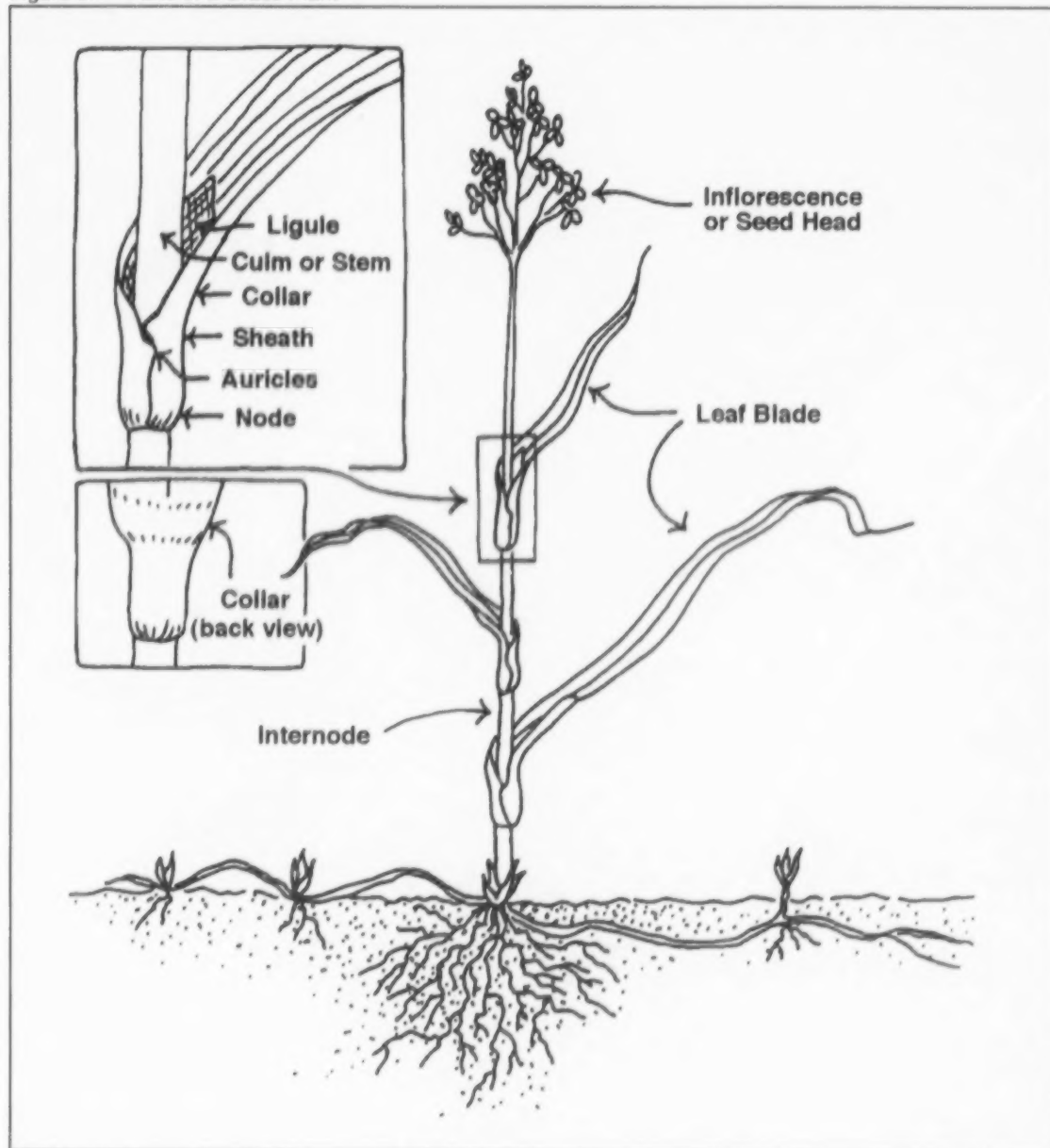
The last lesson showed how plants can be similar, but the focus in this lesson is on the characteristics that can be used to distinguish between different plants. These characteristics will help in the identification of all grassland plants. Managing a

grassland is easier if the plants growing in the area are identified.

Structural Parts of a Grass

The parts of a grass plant include the roots, culm, node (solid portion of the culm), internode, leaf sheath, leaf blade, collar, auricle, ligule, and inflorescence. See Figure 3.1.

Figure 3.1 - Parts of a Grass Plant

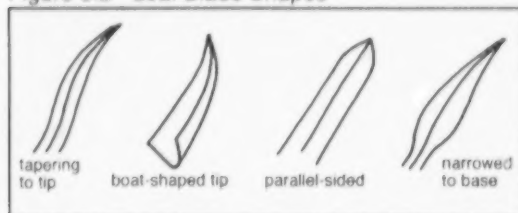


Introduction to Grassland Management

Identifying Characteristics of Grasses

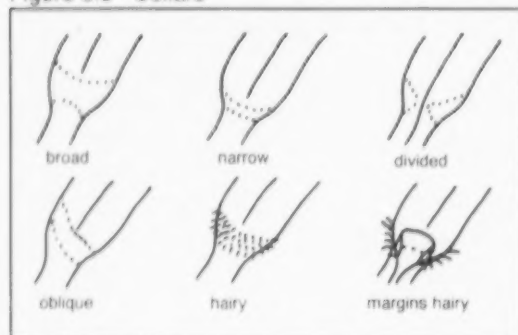
Leaf blade shape - The leaf offers several identifying characteristics. The width, length, and hairiness of the blade differ in each species; they also vary with the environment. The leaf blade and tip shape is a more distinctive identifying characteristic. The blade may be tapering to the tip, boat-shaped, parallel-sided, or narrowed to the base. See Figure 3.2 for examples of these shapes.

Figure 3.2 - Leaf Blade Shapes



Collar - The collar on a grass blade is the external narrow band found where the blade and the sheath join. It can have different shapes (broad, narrow, divided, oblique) and different colors. The collar may also be found with hair or with a hairy margin. Figure 3.3 shows different collars.

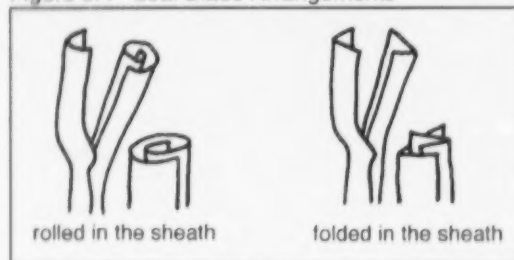
Figure 3.3 - Collars



Leaf blade arrangement - Leaves may be arranged in the sheath in two ways--folded or rolled. To determine which arrangement exists, look at the way a new leaf naturally emerges from the sheath or find the last fully emerged leaf and cut the sheath just below the collar. See Figure 3.4 for leaf blade arrangements.

Sheath - The sheath is the part that encircles the stem and the bud shoot. In a cross section, the sheath will usually be round (or nearly round) if the bud shoot is rolled and flat if the bud shoot is folded.

Figure 3.4 - Leaf Blade Arrangements



The sheath may be split, closed, or split with overlapping margins, as shown in Figure 3.5.

Figure 3.5 - Sheath



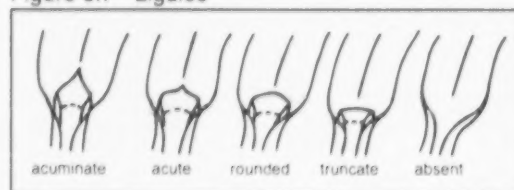
Auricles - The auricles are flaplike appendages that clasp the stem at the top of the sheath. They may be large, small, or absent entirely. See Figure 3.6 for examples.

Figure 3.6 - Auricles



Ligule - The ligule is the upright projection of tissue at the internal junction of the blade and the sheath. The shape, texture, and length are usually the same within each species. The shape of the ligule may be acuminate, acute, rounded, truncate, or absent, as illustrated in Figure 3.7.

Figure 3.7 - Ligules



Roots and Modified Stems

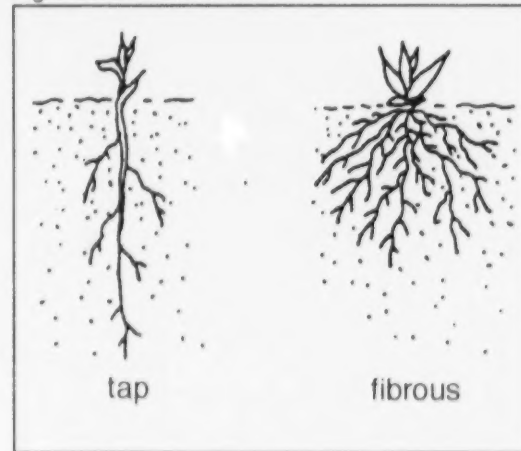
Root systems found in grassland plants differ. The two basic root structures that can be found in grassland plants are tap and fibrous roots. An annual usually has a weak fibrous root system that pulls out of the ground easily without tearing the top from the roots. Figure 3.8 shows the different root structures.

Rhizomes and stolons are modified stems. Rhizomes branch off from the main plant underground. Stolons are stems that grow horizontally along the ground's surface. They both root and send up shoots at nodes along the stem. The two types of modified stems are illustrated in Figure 3.9.

Inflorescence of Grassland Plants

The inflorescence, or arrangement of flowers, of a grassland plant can help in its identification. Grassland plants have six basic arrangements of flowers--spike, raceme, panicle, terminal, axillary, and umbel. On specific plants, slight variations of the inflorescence from the basic structure may

Figure 3.8 - Root Structures



appear. See Figure 3.10 for drawings of each type of inflorescence.

Leaf Structure and Arrangement

Leaf parts - The basic parts of a leaf on legumes, forbs, and woody plants are the petiole, stipules,

Figure 3.9 - Modified Stems

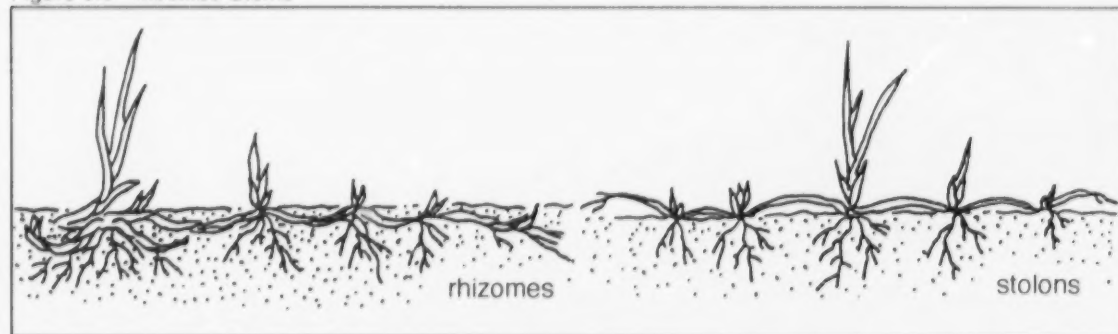
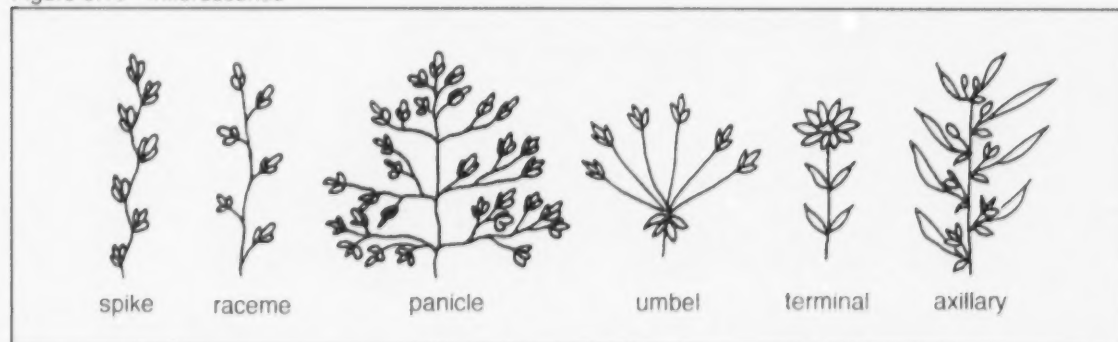
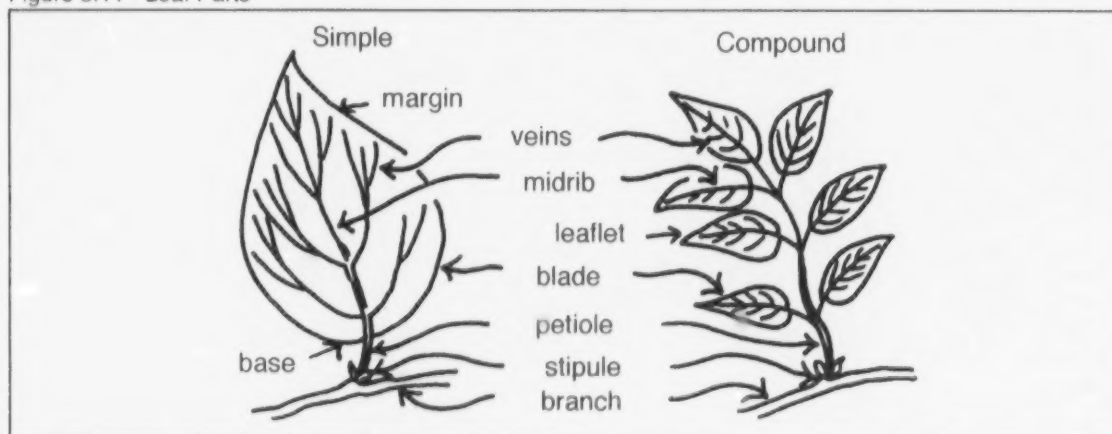


Figure 3.10 - Inflorescence



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Figure 3.11 - Leaf Parts



base, and blade. See Figure 3.11. The petiole is the stalk that connects the leaf to the stem. Stipules are small leaf-like structures sometimes found at the base of the petiole. They usually occur in pairs. The base is the bottom area of the leaf where the petiole connects to the blade. The blade is the flat, large part of the leaf, containing leaf tissue, a midrib (the large central vein from which all other veins branch), and veins. Photosynthesis and respiration occur in the leaves.

The blade surface texture may be described in one of three ways.

- glabrous - smooth and shiny
- pubescent - covered with hair

- glaucous - covered with fine, waxy, whitish bloom

Leaf and bud arrangement - Leaves and buds can be attached to the stem in different arrangements. They may be alternate, opposite, whorled, or basal. In the alternate arrangement, the leaf or bud is located singly at different heights alternating from side to side along the length of the stem. In contrast, the leaves are located directly opposite each other in pairs along the stem in the opposite arrangement. The whorled arrangement consists of three or more leaves or buds arranged in a circle at one point on the stem. Finally, the leaves are located at the base of the stem in a plant with a basal arrangement. See Figure 3.12.

Figure 3.12 - Leaf and Bud Arrangements

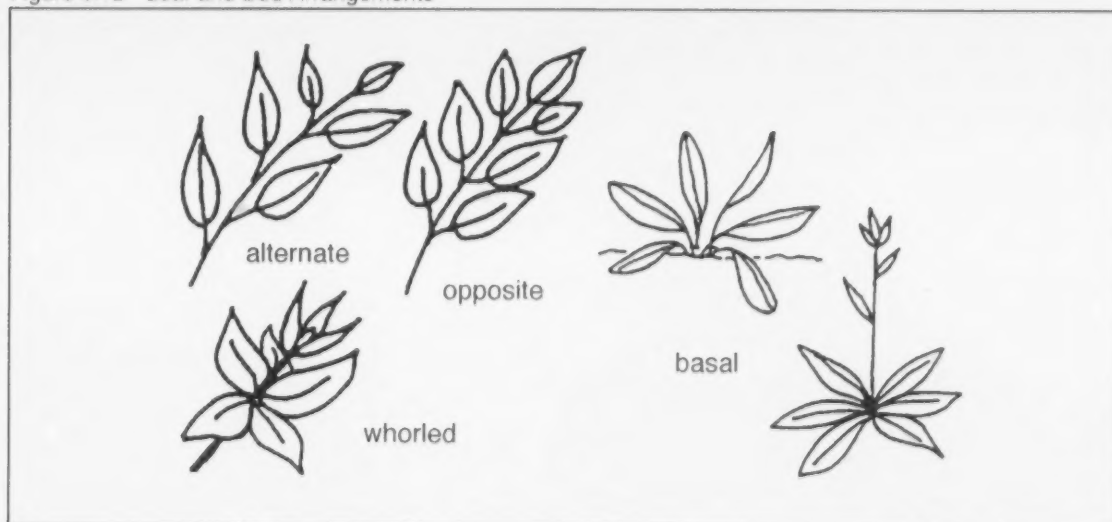
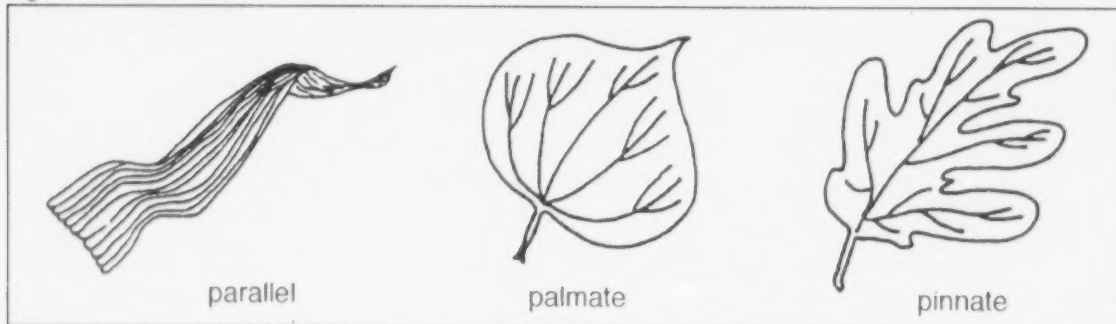


Figure 3.13 - Leaf Venation

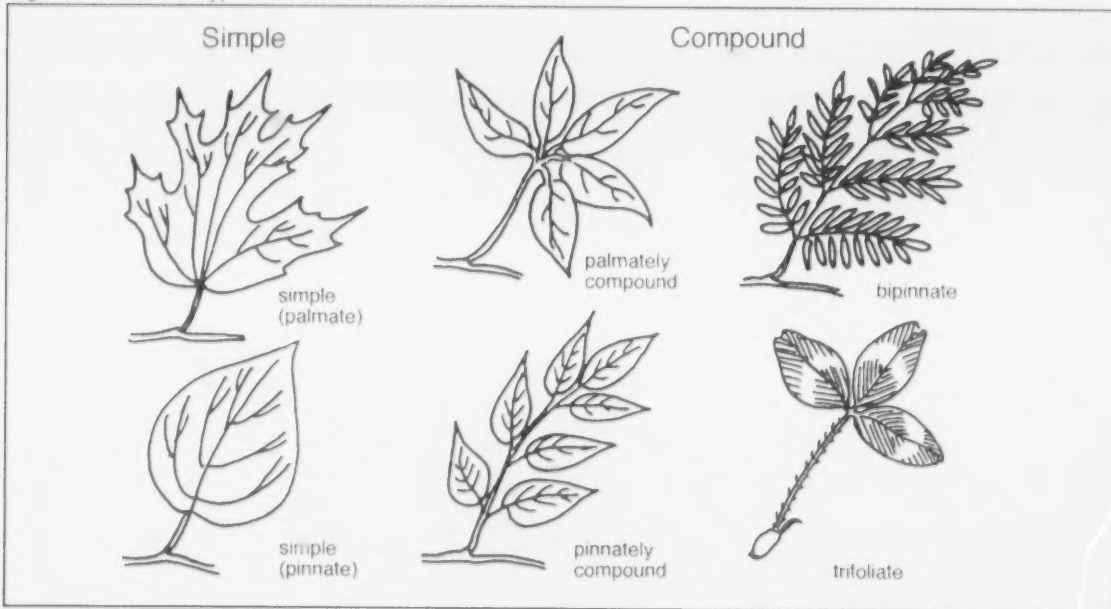


Venation - Leaf venation, or the arrangement of veins in a leaf, is another identifying feature of legumes, forbs, and woody plants. Plants may have two types of venation--parallel (as found on grasses) and netted. Netted venation can be either palmate or pinnate in structure. In palmate venation, all of the main veins fan out from the same point at the base of the blade. Leaves with pinnate venation have a midrib running the length of the blade and smaller veins branching out from it. See Figure 3.13.

Leaf type - Figure 3.14 diagrams different types of leaves. Leaf structure may be characterized as one of the following:

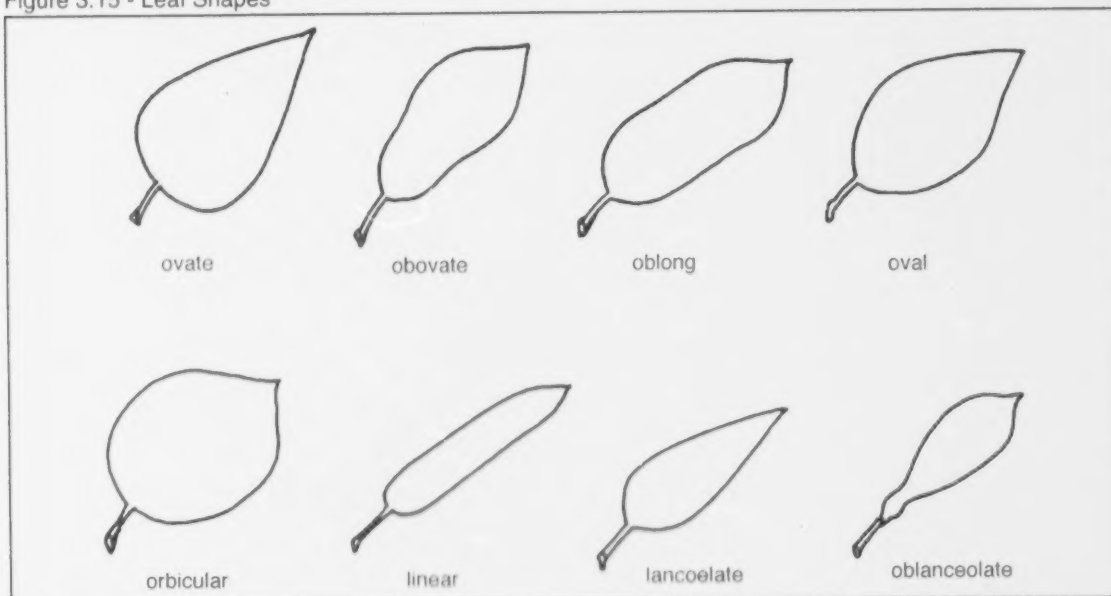
- Simple - One blade rises from the petiole. It may have lobes.
- Compound - More than one small leaf, or leaflet, rises from the same petiole.
 - Palmate - All the leaflets attach to the same point at the tip of the petiole.
 - Pinnate - Pinnately compound leaves have a long stem, or rachis, to which the smaller leaflets are attached on both sides.
 - Bipinnate - Bipinnately compound leaves are divided twice, with the primary leaflet being divided into secondary leaflets.
 - Trifoliate - Trifoliate leaves have three leaflets. They can be palmate or pinnate.

Figure 3.14 - Leaf Types



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Figure 3.15 - Leaf Shapes



Leaf anatomy - Leaf shapes, margins, bases, and tips can all be used in identifying plants. Leaf shape is the overall silhouette of the leaf. A leaf may be long and thin, fat at one end and thin on the other, or round or oval. Some of the more common shapes are shown in Figure 3.15.

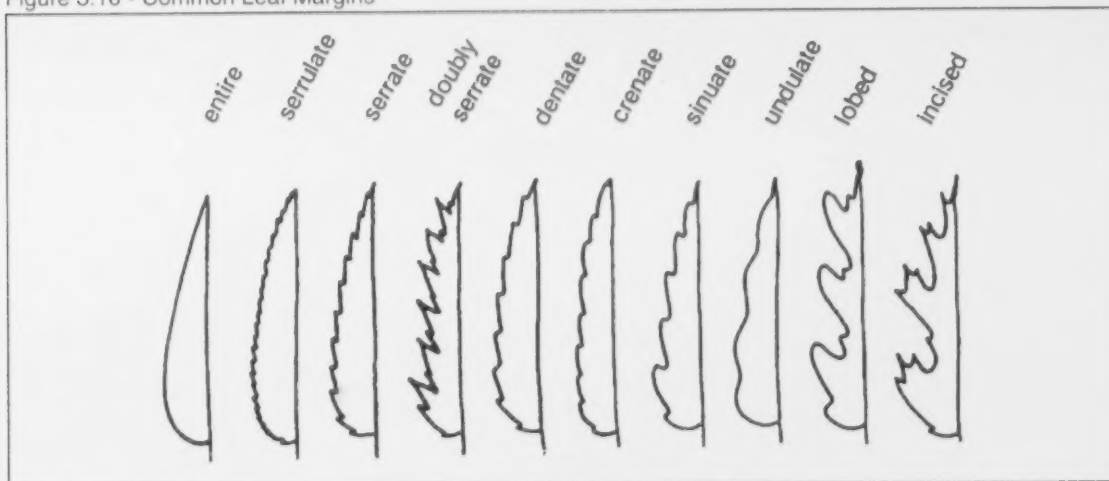
Leaves have differently shaped margins. The margin is the outside edge of the leaf blade. Some of the more common leaf margins are shown in Figure 3.16.

The base of a leaf has a distinctive shape where the blade intersects with the petiole. The tip, or apex, of a leaf also varies in shape. Some of the more common base shapes are shown in Figure 3.17. Figure 3.18 illustrates some of the more common leaf tip shapes.

Stem Shape

Stem shape may also be used in the identification process. When examined in cross section, stems may be square, round, oval, or triangular in shape.

Figure 3.16 - Common Leaf Margins



Grasslands and Grassland Plants

Figure 3.17 - Common Base Shapes

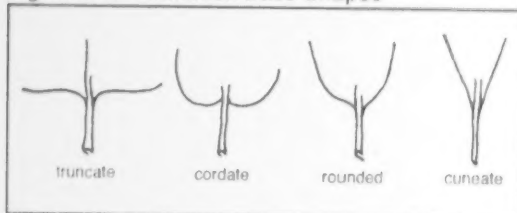
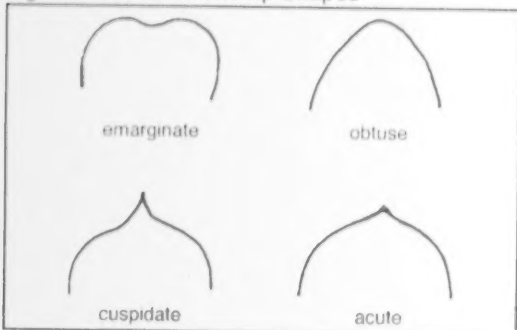


Figure 3.18 - Common Tip Shapes

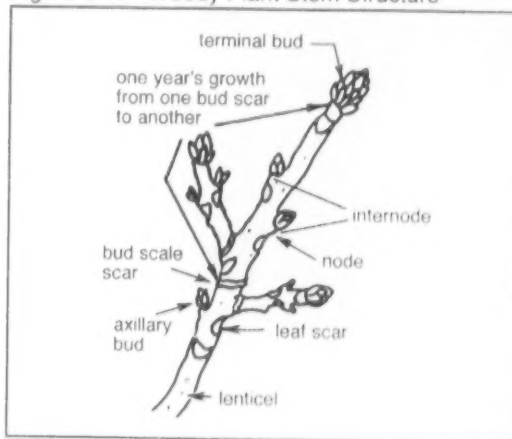


For example, sedges have triangular stems, while mints have square stems. Stem shape can be used to differentiate between two species that are similar to each other, such as Canada bluegrass, which has a flat stem, and Kentucky bluegrass, which has a round stem.

Stem Structure of Woody Plants

Woody plants can be identified by the external structure of the stems. A typical stem has a terminal bud and axillary, or lateral, buds. The terminal bud is the point where the new season's growth starts; it is usually larger than a lateral bud and is found at the stem tip. Terminal buds may be flowering buds, which can be distinguished by their large, round appearance, or vegetative buds, which are thin and narrow and give rise to new leaves or stems. Axillary buds are found on the side of the stem and may be flowering or vegetative. All buds grow out of nodes, which are joints from which leaves or branches grow. The distance between adjacent nodes is the internode. A terminal bud scar is found where the previous year's terminal bud was located. The distance between two terminal bud scars shows one year's growth. Lenticels are breathing pores found scattered on the stem. A leaf scar is found where a leaf was attached to the stem. See Figure 3.19 for an illustration of the different parts of a woody plant stem.

Figure 3.19 - Woody Plant Stem Structure



Summary

The basic characteristics by which grassland plants can be identified are presented in this lesson. Grasses generally need to be identified in their vegetative state because they do not flower until late in the season. The structural parts of grasses are used to identify the vegetative plant. Each forb, legume, and woody plant has its own stem structure, bud shape and size, leaf structure, and leaf arrangement that makes it unique. All of the variations in plant parts between different species do not necessarily need to be memorized, however. In working with grassland plants, an individual gradually learns which plant has which characteristics.

Credits

Barnes, Robert F., Darrell A. Miller, and C. Jerry Nelson, eds. *Forages, Volume 1: An Introduction to Grassland Agriculture*. 5th ed. Ames: Iowa State University Press, 1995.

Lab 2: Vegetative Characters. <http://csdl.tamu.edu/FLORA/tflab/vegchar.htm> (3 July 1997).

Mackenzie, Betsy, and John Frett. *Glossary of Taxonomic Terms Commonly Employed in the Identification of Woody Plants*. http://bluehen.ags.udel.edu/gopher-data2/botanic_garden/glossary.txt (3 July 1997).

Rodekohr, Sherie, and Debi Waeckerle. *Landscaping and Turf Management*. University of Missouri-Columbia: Instructional Materials Laboratory, 1990.

Lesson 4:

Grassland Composition

Grassland composition and forage quality are two ways in which an area can be evaluated for production. In combination with soil and land evaluation (covered in Unit II), they form the evaluation process used in grassland management.

Importance of Grassland Composition

Grassland composition refers to the quality and variety of plants that grow in the grassland. Determining grassland composition is important because understanding the current condition of the grassland helps a producer estimate its potential for livestock production and wildlife management. The quality of the plants that make up a pasture affects the quality of the livestock produced and the wildlife found in the area. Many economic benefits may be gained from maintaining high quality pastures, while nonmonetary benefits may result from providing a good habitat for wildlife.

Knowing the plant composition of the grassland also has other benefits. Examining grassland composition allows the grassland manager to determine the length of the grazing season based on the seasonal growth of the plants. The grassland manager can also use his or her knowledge of grassland composition to adjust the plant composition of pastures to reach the optimum economic yield from production and achieve the most successful wildlife management. This adjustment involves modifying the current composition to match the ideal composition. Improving the composition to improve the quality of the plants and lengthen the grazing season can improve the use of the land.

Components of Grassland Composition

Determining grassland composition can be done by making a visual appraisal of a given area of land. Overall, the more leafy the stand, the higher the quality.

A more specific method of making an appraisal of grassland composition is to use a stick to find the percentages of different plants in the grassland. The person doing the evaluation takes ten steps in a random direction at a representative spot in the grassland. The stick is then placed on the ground

on end. Whatever plant the tip lands on should be recorded, and the total number of each of the plants the stick touches should be tallied in a systematic way. At least ten to twenty determinations should be made. The percentage of each plant in the grassland can then be calculated.

The dominant plants in grasslands are usually grasses and legumes. These plants are the main forage crops. They may be grown in single stands or in mixtures in which two or more forage crops dominate the grassland. Stands composed of only one plant species are of less value to livestock and wildlife. Cool-season and warm-season grasses are not often mixed in the same stand because this combination is difficult to maintain.

Grassland plants not beneficial to livestock production goals are considered to be weeds. Weeds may be any type of plant that is not desired for production. It is important to remember, however, that wildlife may have uses for the plants many people think of as weeds; some of these plants may also have nutritive value for livestock.

Grassland Viability

The needs of livestock and wildlife in the grassland are very similar. They share the same basic needs for food, shelter, and water, although the specific kinds of food and shelter required by livestock may differ from that required by wildlife.

Quality food - A grassland must provide quality food to sustain a population of animals. Nearly all the different parts of plants are eaten by one animal species or another. Livestock need a quality stand of forages, including warm-season grasses, cool-season grasses, and legumes, to sustain the herd. Wildlife usually require a greater mixture of plants, since different animals may feed on leaves, stems, twigs, bark, roots, fruits, seeds, insects, or small mammals supported by these plants.

Shelter - In grasslands, shelter provides protection from harm. Livestock use shelter to reduce the effects of sun, heat, wind, and cold. In addition, wildlife need shelter for nesting and protection from predators. The terrain of the land and large plants like trees provide shelter. Wildlife also find safety in brush piles and nearby woods and among tall grasses.

Water - Clean, uncontaminated water is necessary for sustaining all animals in the grassland. Water

Introduction to Grassland Management

quality in ponds, streams, and groundwater is influenced by the surrounding vegetation. Proper grassland management helps maintain quality water in these sources by preventing erosion, limiting runoff, and filtering nutrients and wastes.

Livestock require a source of surface water. The best source is from a freeze-proof water tank located below a pond or at a water hydrant. Some species of wildlife, such as deer, can drink from streams or ponds, while others, like quail and rabbits, obtain most of their moisture from berries, plants, or even dew.

Forage Quality

Forage quality refers to the nutritive value of the forage needed to produce a desired level of animal performance. The type of performance will depend on the use of the animal. It could be milk production (lactation) for dairy cattle, gain for beef cattle, or work for horses.

A detailed chemical analysis can be run on a forage to measure its quality. This test measures several items.

- Moisture - Testing can reveal the amount of water present in the forage.
- Crude protein (CP) - Crude protein includes both true protein and non-protein nitrogen. The percentage of crude protein indicates the ability of the forage to meet an animal's requirements for protein.
- Acid detergent fiber (ADF) - Acid detergent fiber indicates the percentage of plant material that is indigestible. A low ADF is preferred, because as it increases, the forage becomes less digestible and contains less energy.
- Neutral detergent fiber (NDF) - Neutral detergent fiber refers to the percentage of structural or cell wall material in the forage. A low NDF is preferable, since it correlates to increased feed intake.
- Total digestible nutrients (TDN) - Total digestible nutrients represents the percentage of digestible material in the forage. The higher the ADF is, the lower TDN will be.
- Net energy for lactation (NE_L) - This measurement indicates the energy available in a forage to meet the requirements of lactating cows.
- Net energy for maintenance (NE_m) - Net energy for maintenance indicates the energy available

in a forage to meet the requirements for maintenance in meat-producing livestock.

- Net energy for gain (NE_g) - This measurement indicates the amount of energy available in a forage to produce growth or gain.

These levels will vary according to a number of factors that affect forage quality. The plant's stage of growth is the most important factor. Plants that are young are of higher quality than older, more mature plants. As plants mature, they produce more stem than leaves. The nutritive value of the forage crop decreases with increased maturity because the plants have more indigestible material due to their higher fiber content.

Another important factor is the type of forage. Plant species differ, in their digestibility and energy content. For example, legumes tend to be higher in digestibility than grasses.

A third factor affecting quality is the growing conditions for the forage. The surrounding environment plays a role in determining the value of the plants for forage. The temperature, amount of sunlight, and amount of rainfall all have an effect.

The presence of noxious weeds also has an effect on forage quality. Weeds affect intake by livestock because they are less palatable. They are also less nutritious than desired forages.

Summary

The evaluation of grassland composition allows a producer to estimate the potential for livestock production and wildlife management, determine the length of the grazing season, and modify the plant composition. Determining grassland composition can be done by making a visual appraisal of the land. Grassland viability is also important; livestock and wildlife require food, shelter, and water from the grassland. The quality of the forage on the grassland is vital, since it affects the level of performance of livestock. Factors that influence forage quality include stage of growth, plant type, growing conditions, and the presence of noxious weeds.

Credits

Barnes, Robert F., Darrell A. Miller, and C. Jerry Nelson. *Forages, Volume I: An Introduction to Grassland Agriculture*. 5th ed. Ames: Iowa State University Press, 1995.

Grasslands and Grassland Plants

Coambes, Howard, John Jennings, and David E. Pitts. *Grassland Evaluation Contest Study Guide*. University of Missouri - Columbia: Instructional Materials Laboratory, 1998.

Forage Information System. "Chemical Analysis." [http://www.forages.css.orst.edu/Topics/FQT/Chemical analysis](http://www.forages.css.orst.edu/Topics/FQT/Chemical%20analysis) (12 March 1997).

Forage Information System. "What is Quality?" <http://www.forages.css.orst.edu/Topics/FQT/WIQ/index.html> (12 March 1997).

Hall, Marvin H. "Putting Forage Quality in Perspective." <http://www.cas.psu.edu/docs/casdept/agronomy/forage/docs/quality/perspective.html> (12 March 1997).

Pitts, David E., and William McGuire. *Wildlife Management for Missouri Landowners*. Jefferson City: Conservation Commission of the State of Missouri, 1991.

Schroeder, J. W. "Interpreting Forage Analysis (AS-1080)." North Dakota State University extension publication May 1994. <http://www.ext.nodak.edu/extpubs/plantsci/hay/r1080w.html> (12 March 1997).

Thiex, Nancy, and Ed Twidwell. "Interpreting Forage Analysis." <http://www.sdstate.edu/~cm10/http/INTERP.HTML> (12 March 1997).

Figure 1.1 - Soil Test Report

University Extension UNIVERSITY OF MISSOURI COLUMBIA		Soil Test Report		Soil Testing Laboratory 23 Mumford Hall, MU Columbia, MO 65211 Phone: (573) 882-0822		or Soil Testing Laboratory P.O. Box 180 Portageville, MO 63873 Phone: (573) 378-5431				
FIELD INFORMATION						Serial no. M9999 Lab no. 9969999				
Field ID <u>Hill top field</u> Sample no. <u>1</u>						Area <u>015</u> County <u>010</u> Region <u>3</u>				
Acres <u>40</u> Last Used <u>Not known</u> Irrigated <u>No</u>						Submitted <u>06/10/96</u> Processed <u>06/12/96</u>				
Last crop <u>019 Cool-Season Grass Pasture</u>						Soil sample submitted by:				
This report is for: Example Report University of Missouri Columbia, MO 65211										
B SOIL TEST INFORMATION					C RATING					
					Very low	Low	Medium	High	Very High	Excess
pH _s	(soil pH)	4.2								
Phosphorus	(P)	22								
Potassium	(K)	lbs/acre								
Calcium	(Ca)	101								
Magnesium	(Mg)	lbs/acre								
Sulfur	(S)	ppm								
Zinc	(Zn)	ppm								
Manganese	(Mn)	ppm								
Iron	(Fe)	ppm								
Copper	(Cu)	ppm								
Organic matter	%	2.2	Neutralizable acidity		6.0 meq/100g		Cation Exch. Capacity		12.8 meq/100g	
pH in water			Electrical Conductivity		micromhos		Sodium (Na)		lbs/a	
Nitrate (NO ₃ -N)	Topsoil	ppm	Subsoil	ppm	Sampling Depth	Top	Inches	Subsoil	Inches	
E CROPPING OPTIONS					F YIELD GOAL					
					G POUNDS PER ACRE					
					H LIMESTONE SUGGESTIONS					
Alfalfa/Grass					Effective neutralizing material (ENM)					
Establishment					1.395					
Clover/Grass Establishment					Effective magnesium (EMg)					
Alfalfa/Grass Hay										

I To determine limestone need in tons/acre, divide ENM requirements by the guarantee of your limestone dealer.

When N requirement for cool-season grass exceeds 90 lbs/acre, apply 2/3 of it during the period from December through February, and the remainder in August.

Do not use nitrogen on spring seedlings of legumes after May 1st because of potential weed competition.

Area Agronomy Specialist Agronomy Specialist Phone (573) 882-1000

White - Farmer, Yellow - ARCS, Blue - Firm, Pink - Extension MP 130 Revised 1/90 Signature

University of Missouri, Lincoln University, U.S. Department of Agriculture & Local University Extension Councils Cooperating
equal opportunity institutions

Lesson 1: Soil Tests

Grassland soils are important in meeting production goals on any given plot of land. To best manage the area, analyses to evaluate the fertility status of the soil must be performed. A soil test report, which provides information from such tests, is a valuable tool in grassland management.

The procedures used to collect a soil sample may influence the results of the test. A representative sample must be taken from within the grassland; for example, wet spots as well as dry spots should be represented. Ideally, about fifteen to twenty subsamples should be taken to a depth of six to seven inches and then combined in a composite sample. Once the sample is taken, it may be analyzed by the University Extension service or private soil testing labs.

Soil Test Information

Soil test reports should include the following information (see Figure 1.1).

Field information (A) - This section contains information provided by the producer to identify the field and summarize previous management. This information includes, for example, the field name or number, field size, and previous crop.

Soil test information (B) - This section provides the results of the soil tests performed on the sample. The regular soil tests include the soil salt pH; available phosphorus, potassium, calcium, and magnesium; organic matter; neutralizable acidity; and cation exchange capacity. Tests for other nutrients can be obtained at additional charge. The basic set of tests provides the necessary data to develop nitrogen, phosphate, potash, and agricultural lime recommendations for the intended cropping plan.

Rating (C) - This section provides a rating for the salt pH and nutrients tested. The rating system helps interpret the soil test information in Section B.

Nutrient requirements (D) - This section contains three parts: cropping options, yield goal, and fertilizer recommendations.

Cropping options (E) - This section lists cropping plans or crops for which fertilizer recommendations were requested. Recommendations can be given for up to four different cropping scenarios. Additional scenarios can be done at the local University Extension center if plans change after the lab report comes back.

Yield goal (F) - The yield goal section shows the level of production selected for the crops listed in Section E, "Cropping Options." The yield goal chosen should be based on soil type, yield history, fertility level, presence of irrigation, and economic considerations.

Pounds per acre (G) - This section lists the fertilizer recommendations for the crops and yield goals listed. The recommendations are reported as pounds of N (nitrogen), P_2O_5 (phosphate), and K_2O (potash) per acre. The fertilizer recommendation is designed to provide an agronomic recommendation of the nutrients needed to meet the yield goal in Section F and improve soil fertility over time. Following these soil test recommendations will increase or maintain the levels of phosphorus and potassium needed for the high rating category if the recommended fertilizer rate is applied annually for eight years. Micronutrient recommendations, such as zinc, should be applied once and the soil resampled in three to five years to determine the need for additional applications.

Limestone suggestions (H) - This section gives the suggested amount of limestone to raise soil salt pH to an optimal level for the cropping options listed. Desired soil salt pH ranges for Missouri crops are given in Figure 1.2.

The limestone recommendation is given for the cropping option requiring the highest salt pH range. For example, if a cool-season grass and alfalfa were both listed in Section E, the limestone recommendation would be for alfalfa since it requires a higher soil salt pH level. The recommendation is reported as pounds of effective neutralizing material (ENM) per acre.

Special notes (I) - Many times notes appear at the bottom of the soil test report to help the producer interpret and use the results and recommendations.

Interpreting the Soil Analysis

The basic soil test in Missouri provides results for the pH_s , phosphorus, potassium, calcium,

Introduction to Grassland Management

Figure 1.2 - Desired Soil Salt pH Ranges for Missouri Crops

Crop	Soil region	
	Ozark and borders	Other
Alfalfa and alfalfa-grass establishment	6.6-7.0	6.1-6.5
Birdsfoot trefoil and birdsfoot trefoil-grass establishment	6.1-6.5	5.6-6.0
Clover and clover-grass establishment	6.1-6.5	5.6-6.0
Cool-season grass establishment and production	5.6-6.0	5.6-6.0
Lespedeza and lespedeza-grass establishment	6.1-6.5	5.6-6.0
Overseeding legumes	6.1-6.5	5.6-6.0
Warm-season grass establishment and production	5.6-6.0	5.6-6.0
Sudan grass and sudan/sorghum crosses	5.6-6.0	5.6-6.0
All row crops	6.1-6.5	6.1-6.5



magnesium, organic matter, neutralizable acidity, and cation exchange capacity of the soil sample.

The pH_s , or salt pH, is a numerical measure of the relative level of soil acidity. Salt pH refers to the salt solution used in the laboratory to measure the pH of the soil sample. Some laboratories used water instead of a salt solution for pH measurements and these results are simply reported as pH. Crops require different pH levels for optimum growth and yield. Proper pH levels help to improve root development and provide a good environment for soil microorganisms. Soil pH_s for some crops differs among regions of the state.

Phosphorus (P) is the second line of the table. The test for phosphorus measures the relative availability of phosphorus to the plant for growth, not the total amount in the soil. The ratings range from very low to very high.

Potassium (K) is measured by the amount available for plant growth (also referred to as exchangeable potassium) and not by total potassium in the soil. The cation exchange capacity (CEC) of the soil and the current level of exchangeable potassium are used to determine the need for additional potassium. Generally, as the CEC increases, so does the desired level of exchangeable potassium.

Calcium (Ca) is measured to help calculate the CEC of the soil. The rating for calcium levels is based on the soil pH. Soils with very low to low soil pH will rate medium for calcium, and soils with pH of

medium to high will rank high for calcium. Missouri soils are rarely in need of calcium.

Magnesium (Mg) is only added when levels are very low to medium. For soils that are rated very low to low, crop yields will be improved with applications of magnesium. When lime and magnesium are both needed, dolomitic limestone may be applied because it contains calcium and magnesium.

Organic matter (O.M.) is the decayed plant material, or humus, in the soil. The level of organic matter is used to determine the potential nitrogen available to a crop during the growing season.

Neutralizable acidity (N.A.) measures the exchangeable hydrogen. It is a measure of the reserve acidity in soil, or its ability to remain acid. Higher N.A. indicates more reserve acidity. This figure aids in the calculation of liming requirements for the soil.

Cation exchange capacity (CEC) measures the soil's ability to hold positively charged nutrients called cations--calcium, magnesium, potassium, and hydrogen.

Routine fertilizer recommendations are made for the major nutrients used by plants. Nitrogen, phosphorus, and potassium are the major nutrients applied in fertilizer for forage production. In some cases, sulfur or micronutrients like zinc (Zn), manganese (Mn), iron (Fe), and copper (Cu) may be added when they become deficient in the soil.

Table 1.1 - Probability of Yield Increase from Fertilizer Application

RATING						Probability of response
Very low	Low	Medium	High	Very high	Excess	to fertilizer
*****						very high
*****						high
*****						medium
*****						low
*****						none

The amount of nitrogen (N) that needs to be added to the soil is determined by the cropping option, soil texture, and organic matter. The figure is expressed in pounds of nitrogen needed per acre.

Phosphorus and potassium are added in the fertilizer mix based upon the soil test and the desired yield of a particular crop. Phosphorus is added in fertilizer to build up or maintain the current level of phosphorus in the soil. Potassium levels needed for alfalfa hay, row crops, and small grains are calculated by the following formula: $220 + 5(\text{CEC}) = \text{lbs. K/acre}$.

Fertilizer Application and Yield Response

The soil test rating in Section C indicates the relative level of each nutrient tested and provides information on the probability that the application of a particular fertilizer will increase crop yield. Table 1.1 can be used to determine the probability of a yield increase from fertilizer applications for each soil test rating. The probability of an increase in yields from fertilizer drops as the soil test rating rises. For example, soil with a rating of very low for a particular nutrient is much more likely to respond to fertilizer than soil with a rating of medium for that nutrient.

Liming to Increase pH

Agricultural limestone is tested based on purity and fineness of grind. These results determine the limestone's effective neutralizing material, or ability to reduce soil acidity. A producer can call an agricultural lime dealer at a quarry to find out the local ENM. This figure and the ENM required by the soil (provided on the soil test report) are all that is necessary to calculate the tons of limestone needed per acre, as shown in the formula below.

$$\frac{\text{ENM required by the soil test}}{\text{ENM of agricultural limestone}} = \text{tons of limestone/acre}$$

To determine the amount of lime needed in tons per acre, divide the ENM value from the soil test by the ENM of the limestone. For example, if the soil test ENM requirement is 1,395 pounds per acre and the quarry guarantees 400 pounds ENM per ton of limestone, then 3.48 tons of limestone per acre ($1,395 \div 400 = 3.48$) are needed.

Limestone is applied to neutralize soil acidity and increase salt pH. It does contain calcium, but its main use is to neutralize acidity. Dolomitic limestone contains appreciable amounts of magnesium and is often used on magnesium-deficient soils. Some liming materials have a higher ENM rating than calcitric limestone.

Summary

Soil tests provide important information that can affect a grassland's production. To use the data correctly, an understanding of the soil test results and the suggested treatments is required.

Credits

Dent, David, and Anthony Young. *Soil Survey and Land Evaluation*. London: Allen & Unwin, 1981.

Donahue, Roy L., Roy Hunter Miller, and John C. Schickluna. *Soils: An Introduction to Soils and Plant Growth*. 5th ed. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1983.

University Extension agricultural publications, University of Missouri-Columbia.

G9102: *Liming Missouri Soils*

G9110: *How to Get a Good Soil Sample*

G9111: *Using Your Soil Test Results*

G9112: *Interpreting Missouri Soil Test Reports*

Lesson 2:

Using Soil Survey Manuals

Soil survey manuals provide useful information for grassland management. Soil scientists evaluate the soil for chemical and physical properties, make maps, and interpret the information for agricultural, engineering, recreational, and urban uses.

The characteristics of soils are very important when selecting plants for a grassland. Because soils provide so many vital components required by plants, it is imperative that the soil and plants of a grassland are suitable for each other and can meet the production goals and wildlife needs of the area.

Soil Surveys and Grasslands

The soil survey manual begins with a section on how to use the soil survey that provides an introduction to or review of the manual. A large map called the general soils map, which is used for land use planning, is also included. The general soils map shows the phases, or borders, of the different soil series (groups of similar soils) by means of lines that outline irregularly shaped areas and often follow contour lines.

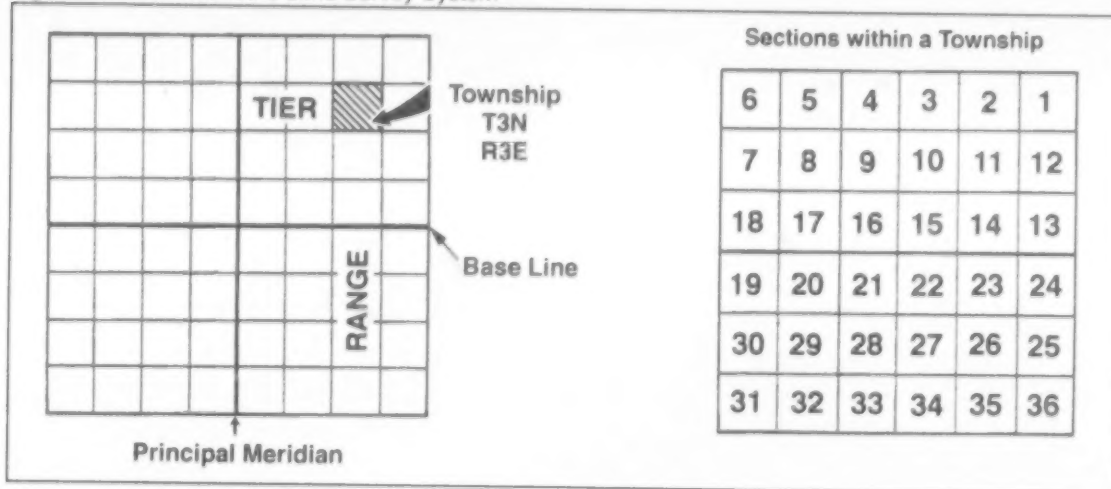
When more detailed planning is necessary to manage a particular grassland, aerial photographs on which the phases of the soil series are drawn can be used to aid in making land use decisions. Information on the use and management of the soils is provided next, describing the land use potential

and management for all areas of interest. The series are also covered in descriptions of the soils, which discusses the soil characteristics, limitations on use, land capability (uses), and suggested management practices. Finally, a section on the formation and classification of the soil is also included. It provides information on uniform systems of soil classification.

Locating Property

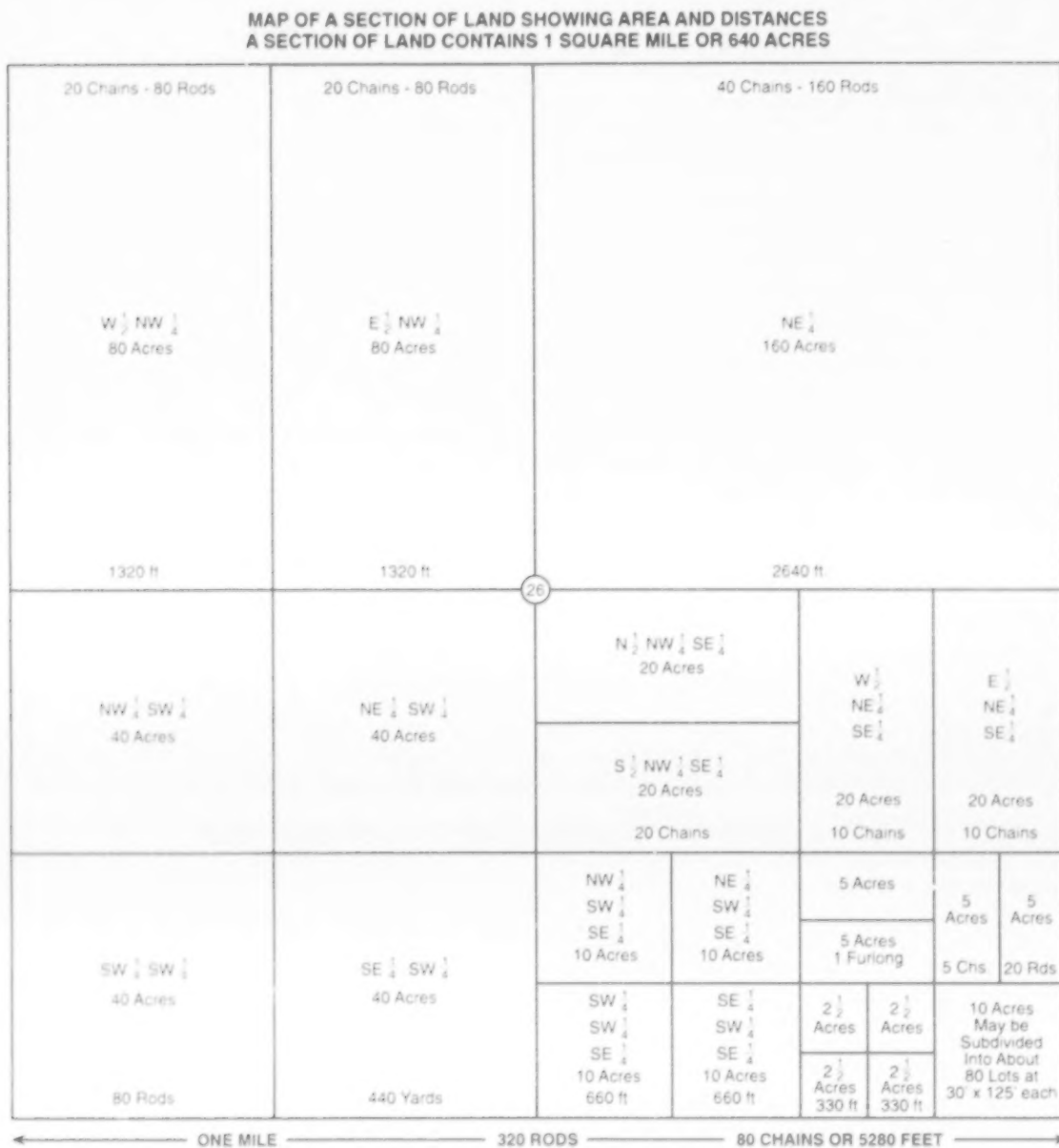
When trying to locate a plot of land in the manual, first find the property in the "Index to Map Sheets." Then turn to the page number of the map sheet indicated by the index and use landmarks and features and/or the U.S. standard land survey system to locate the plot. The U.S. standard land survey system is the method used for locating specific areas of land. The basis of this system is the base line (x-axis) and the principal meridians (y-axis). These two lines act as the reference points from which townships are established. Each township is a six-mile square divided into 36 sections, making each section one square mile. Most sections contain 640 acres, but the sections on the north and west sides may be larger or smaller if corrections need to be made. Sections are broken down into further subdivisions called quarters, which are identified by direction (NW, NE, SW, SE) and contain 160 acres. Each quarter can be divided into smaller components. Townships are numbered from the base line both north (N) and south (S), and the ranges from the principal meridian are numbered east (E) and west (W). See Figure 2.1 for a diagram of the system. Figure 2.2 shows divisions of a section.

Figure 2.1 - U.S. Standard Land Survey System



Introduction to Grassland Management

Figure 2.2 - Divisions of a Section



Soil Limitations

A soil's capability class, which indicates its uses, is determined by the limitations of an area. Limitations can be permanent or temporary. Knowledge of these limitations is of great value to the grassland manager, since it allows the management practices to be customized to the individual needs of the area.

Permanent limitations are not easy to change with conservation practices or management. Examples of permanent limitations include severe slope, soil depth, flooding, and large rocks. Some of these may be changed, although to do so would take great effort and expense, while others cannot be controlled.

Temporary limitations are problems that decrease land use potential but can be improved or removed with the implementation of conservation practices and better management. Examples of temporary limitations would include soil nutrient content, moderate slope, and minor drainage problems.

Soil Classifications

All soils are classified according to their uses and limitations. These soils are either cultivatable (able to produce crops) or non-cultivatable (not able to produce crops). Each of these divisions is broken down into four different levels of cultivation, making eight soil classifications. A piece of property may have land that falls into several different soil classifications.

The cultivatable soils are Class I through Class IV.

Class I (1) - These soils have very few limitations to restrict use. No special treatment is needed for prevention of surface runoff even if the land is cultivated year after year. The land is nearly level with little risk of wind or water erosion. It has deep, well-drained soils that are easy to maintain.

Class II (2) - These soils have a few limitations that reduce the plant choices or that require moderate conservation practices to increase yields.

Class III (3) - Special conservation practices are needed for these soils because of the severe limitations that reduce the choice of plants. These conservation practices are less practical than Class II and require extra effort and costs.

Class IV (4) - Very severe limitations require careful management and/or special

conservation practices on these soils to decrease the limitations that restrict the choice of plants.

Class V through Class VIII are the noncultivatable soils.

Class V (5) - This land is suitable for pasture and wildlife food and cover. It has few erosion hazards and is nearly level or gently sloping. The limitations are difficult to remove and prevent the use of standard farm equipment. The land may be wet, stony, and/or flooded by streams that may decrease the growing season.

Class VI (6) - These soils have severe limitations that reduce the uses of the area to grassland, range (if not overgrazed), and wildlife food and cover.

Class VII (7) - These soils have very severe limitations. An example would be a steep, rocky, eroded hillside.

Class VIII (8) - These areas are mountainous and suitable for wildlife, recreation, and/or water supply.

Classes II through VIII may have an additional label of E for erosion, W for wet, or S for stoniness, shallowness, or droughtiness. These labels indicate special conditions affecting the soil.

Factors Influencing Plant Selection

For plants to perform well, their needs for certain basic requirements must be met. Areas of interest when evaluating a grassland for plant selection are soil texture, soil depth, slope, erosion, surface runoff, permeability, and drainage.

Soil texture - The relative proportions of sand, silt, and clay particles in a soil determine its texture. It can vary from coarsely textured to finely textured with moderately coarse, medium, and moderately fine soils in between. Soil texture affects the amount of contact plant roots have with available water, air, and nutrients.

Soil depth - Soil depth refers to the area that plant roots have available to extend downward. Soil is divided into deep soils, which are more than 36" deep; moderately deep soils, which are 20-36" deep; shallow soils, which are 10-20" deep; and very shallow soils, which are less than 10" deep. Soil depth can limit the type of plants that can root in the soil. For example, if the soil depth is very

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shallow, the plant species that would prosper in that area are limited to short-rooting plants.

Slope - Slope refers to the steepness of the land's surface. It is measured as a percentage calculated by the difference in vertical elevation over a 100-foot horizontal distance. The severity of slope affects erosion and the ability to use farm machinery.

Erosion - The loss of soil by wind or water is erosion. Erosion can decrease the soil depth by removing the topsoil layer, which will decrease the quality of plant growth and limit the number of plants suitable to the area.

Surface runoff - Surface runoff refers to the rate at which water disappears from the soil surface by absorption or flowing over the soil. It can lead to erosion, the leaching of soil nutrients, and/or the washing away of seeds or nutrients.

Permeability - The movement of air and water through the soil is permeability. Root penetration, water movement in and on the soil, and nutrient leaching are all affected by the soil's permeability.

Drainage - Drainage refers to the speed at which water moves from the soil surface. Excessive or poor drainage limits plant growth. Drainage classes are discussed in greater detail in the next section.

Other factors also influence plant selection. Temperature range, rainfall, and length of season are climatic factors that affect plant growth and selection. Economic concerns also affect the selection of plants; one type of seed may cost less than another, making the first more economical, even though both may grow well in that soil.

Drainage Classes

Drainage classes are based on the frequency and duration of the periods during which the soil was saturated (voids between soil particles filled with liquid) or partially saturated when a particular soil was formed. The characteristics of the seven classes are based on: the color and thickness of the subsurface soil layers.

Excessively drained soils - These soils are very porous and freely permeable for great depths.

Somewhat excessively drained soils - Water and air move freely but more slowly than excessively drained soils.

Well-drained soils - They are most often sandy or intermediately textured soils. The color is uniform except near the deep water table, where it becomes mottled or spotty.

Moderately well-drained soils - The soils have slower internal water movement. More mottling appears further up the profile (vertical section of the soil). Artificial drainage is suggested for an alfalfa crop.

Somewhat poorly drained soils - The surface is wet for many weeks throughout the year. Mottling is prominent just below the surface. Artificial drainage is almost always needed.

Poorly drained soils - These soils are wet for many months in the year. Mottling is prominent throughout the profile. Artificial drainage is required for crop growth.

Very poorly drained soils - The soils are wet almost every month of the year. They are usually gray in color with mottling on the surface. Artificial drainage may be difficult to install but is required for crop growth.

Obtaining Soil Manuals

Soil survey manuals for many Missouri counties can be obtained at no cost by Missouri residents and by all non-residents for a fee. Some counties do not have manuals. Contact a local Soil and Water Conservation district office or Natural Resources Conservation Service office to obtain copies if they are available.

Summary

Soil survey manuals are very useful for grassland managers. The maps and other information included in the manual help an individual to understand the potential uses of the soil and the conservation practices that could improve grassland production. Plant selection and growth depends a great deal on the characteristics of the soil. To select the best plants for a given area, these characteristics must be taken into account. Knowing the soil's limitations will improve management decisions made for the grassland.

Credits

Dent, David, and Anthony Young. *Soil Survey and Land Evaluation*. London: Allen & Unwin, 1981.

Donahue, Roy L., Raymond W. Miller, and John C. Shickluna. *Soils: An Introduction to Soils and Plant Growth*. 5th ed. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1983.

Donahue, Roy L., Roy Hunter Follett, and Rodney W. Tulloch. *Our Soils and Their Management*. Danville, Ill.: Interstate Publishers, Inc., 1990.

Minor, Paul E. *Soil Science (Student Reference)*. University of Missouri-Columbia: Instructional Materials Laboratory, 1995.

Lesson 1:

Grasslands and the Nutritional Needs of Livestock

This unit examines grassland management. Managing grasslands effectively is very important for livestock production. It is important to know the nutritional needs of livestock to be better able to meet those needs. Nutritional needs vary according to the type of production required, and the producer needs to be able to adjust daily forage dry matter intake to meet them. The focus of this unit will be on beef cattle, since beef production takes place in nearly every county in Missouri.

Nutritional Needs of Livestock

The nutritional needs of livestock are determined by the type of production (function) that the animals perform. All animals have nutritional needs for maintenance, in which nutrients (carbohydrates, fats, protein, and minerals) are used to maintain vital bodily processes and normal body temperature, with no weight gain or loss and no additional production. Increased amounts of certain nutrients are needed for the other production functions--growth, fattening, reproduction, rebreeding, lactation (milk production), and work.

The specific nutrients needed by the animals depend on the production function. The nutrient needs for each production function are as follows.

- Growth - protein, carbohydrates, fats, minerals, and vitamin D
- Fattening - carbohydrates and fats
- Reproduction - protein, carbohydrates, fats, and minerals
- Rebreeding - carbohydrates, fats, protein, and vitamins

- Lactation - carbohydrates, fats, protein, and minerals
- Work - carbohydrates and fats

The total amount of nutrients needed varies from animal to animal. The level of output required for production affects the amount of nutrients required by a particular animal. For example, a horse that performs in a rodeo will have higher nutritional needs than a horse that provides rides for children at a fair, although both are working. The quantity of nutrients required varies with body size as well. Large animals need more nutrients than do smaller animals.

The nutritional needs of animals can be met by quality forages. The amount of forage required by an animal is given in terms of dry matter (DM), which is the total amount of matter in a forage minus any moisture it contains. Table 1.1 gives guidelines for estimating the forage daily dry matter intake (DMI) requirements for cattle. These figures are given as a percentage of body weight (BW) to account for the differences in requirements due to body size.

Changing Nutrient Requirements

Nutritional requirements of livestock change as the animals go through different stages of production. For example, forage quality must be higher for growing animals than for mature animals. Growing animals, such as steers or heifers, need high quality feed to maintain growth. Shortages in quality will sharply reduce gain and decrease profits. As they mature, the animals' nutritional needs will change since they no longer require nutrients for growth. The forage quality needed by mature animals changes as production varies throughout the year. Mature bulls, for example, need good quality forages during the breeding season but can use lower quality forages at other times of the year.

Table 1.1 - Forage Dry Matter Intake Requirements by Production Class

Class	Forage Dry Matter Intake Requirements Per Day (% of BW)
Dry beef cow	2%
Lactating beef cow (average milk production)	2.5%
Lactating beef cow (superior milk production)	3%
Bull (during breeding season)	2.5%
Bull (out of breeding season)	2%
Growing steers and heifers	3%

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The forage quality needed by mature animals changes as production varies throughout the year. A mature beef cow goes through four stages of production each year, and its nutritional needs will be different for each of these stages. Figure 1.1 illustrates the changing energy needs of the cow.

Stage 1 follows calving and lasts 90 days. Since the cow has just had a calf, her nutrient needs are now the highest of the entire year. She is lactating at her highest level, and her uterus is returning to its normal size after being enlarged during pregnancy. The cow must also cycle and rebreed within 90 days of calving to stay on schedule for production, since cows must rebreed in time to have a calf every 365 days. Failure to do so results in an unprofitable operation due to the added costs of maintaining open, unbred cows. With all the physical demands on the cow, a lack of nutrients during this period results in lower milk production and failure to rebreed. The cow must therefore be fed high quality forages at this time.

In Stage 2, the cow is in the early stages of pregnancy and is lactating to nurse her calf. This stage usually lasts 115 days. Nutritional needs drop slightly during this period because the calf is getting some food from creep feeding, but the cow should be gaining some weight due to pregnancy.

Stage 3 is mid-gestation and lasts about 100 days. The cow has just weaned her calf and is dry. Her nutritional needs are at the lowest point of the entire year, since she only has to maintain herself and the developing fetus. She can get by on much lower quality pasture.

Stage 4 precedes calving. This stage lasts about 60 days and is nutritionally the second most important period during the year. During this stage, 70 to 80 percent of fetal development occurs. The cow is gaining weight and preparing for lactation. Inadequate nutrition during this stage will often cause weak calves and inhibit rebreeding. The cow needs good quality pasture or hay to make sure that both she and the calf will be strong and healthy.

The herd has the highest forage quality requirement after the majority of the cows have given birth, when they are in Stage 1 and require energy for lactation and rebreeding. The growth of cool-season grasses such as tall fescue and orchardgrass meets the nutritional needs of both spring- and fall-calving cows (see Figures 1.2 and 1.3). In spring calving, cows calve just before the peak of grass growth in

May and June, when forage quality is very high. The cow's nutritional needs peak when the grass growth peaks. Fall calving also works well in Missouri, since it matches the period of the cow's highest nutritional needs with another peak in forage growth in October. The calves will be weaned in the spring in time to take advantage of the lush spring pasture growth, ensuring high weight gain.

Summer calving is not recommended. The cow's nutritional needs and cool-season pasture production are mismatched (Figure 1.4). The pasture is at its poorest quality and lowest production right when the cow needs the highest quality feed, after calving. Summertime heat and humidity also reduces rebreeding success; conception rates are low. Warm-season forage could help improve pasture quality but will not offset problems due to heat and humidity.

Calculating Daily Forage Dry Matter Intake

Although cattle need quality forages at specific stages of production, they also need an adequate quantity. Estimating the total amount of forage needed by a herd is not difficult but requires a calculation. The formula for determining daily forage dry matter intake for cattle is as follows.

$$\text{Daily dry matter intake in a class} = \frac{\# \text{ of animals in a class} \times \text{avg. weight per animal} \times \text{forage dry matter intake requirement}}{\text{per animal}}$$

The pounds of forage dry matter needed per day for a herd is equal to the total of the daily dry matter intake for all the classes of cattle in the herd. The following example illustrates how to calculate forage dry matter intake requirements for a herd.

Example: 1 bull - 2,000 lbs.; during breeding season
10 heifers - average weight of 750 lbs.
30 lactating cows - average weight of 1,100 lbs.; average milk production

Solution: 1 breeding bull $\times$ 2,000 lbs. $\times$ 2.5% = 50 lbs.

10 heifers $\times$ 750 lbs. $\times$ 3% = 225 lbs.

30 lactating cows $\times$ 1,100 lbs. $\times$ 2.5% = 825 lbs.

The total for the herd is 1,100 lbs. (50 + 225 + 825 = 1,100 lbs.) of forage dry matter per day.

Figure 1.1 - Energy Needs of a Mature Beef Cow for Spring Calving

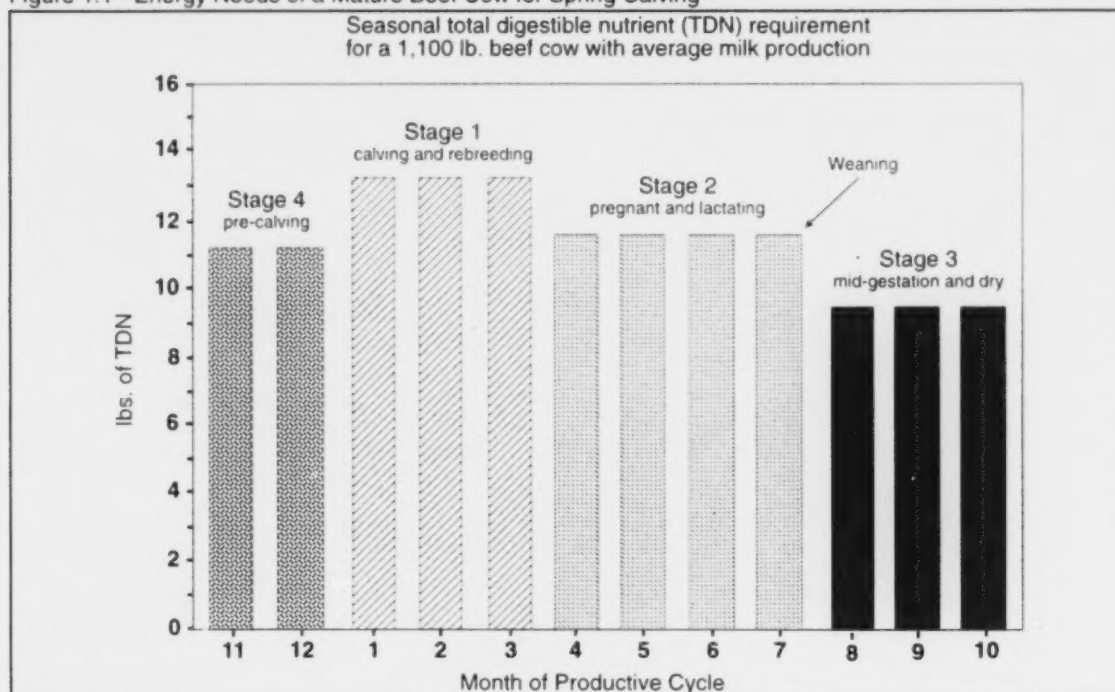
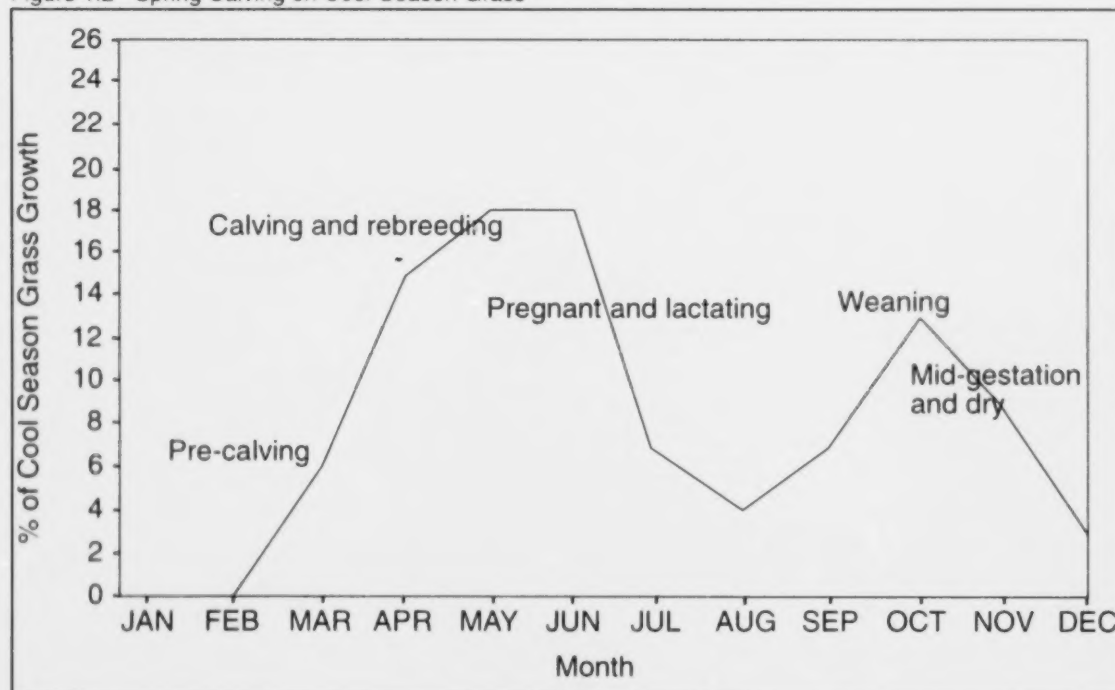


Figure 1.2 - Spring Calving on Cool-Season Grass



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Figure 1.3 - Fall Calving on Cool-Season Grass

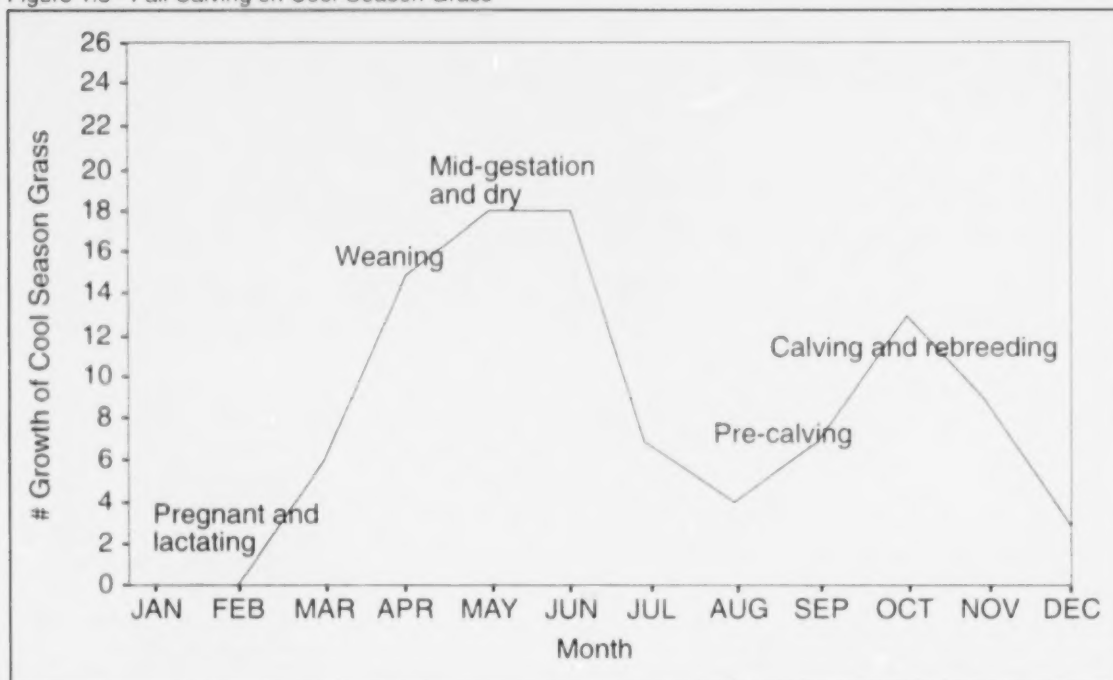
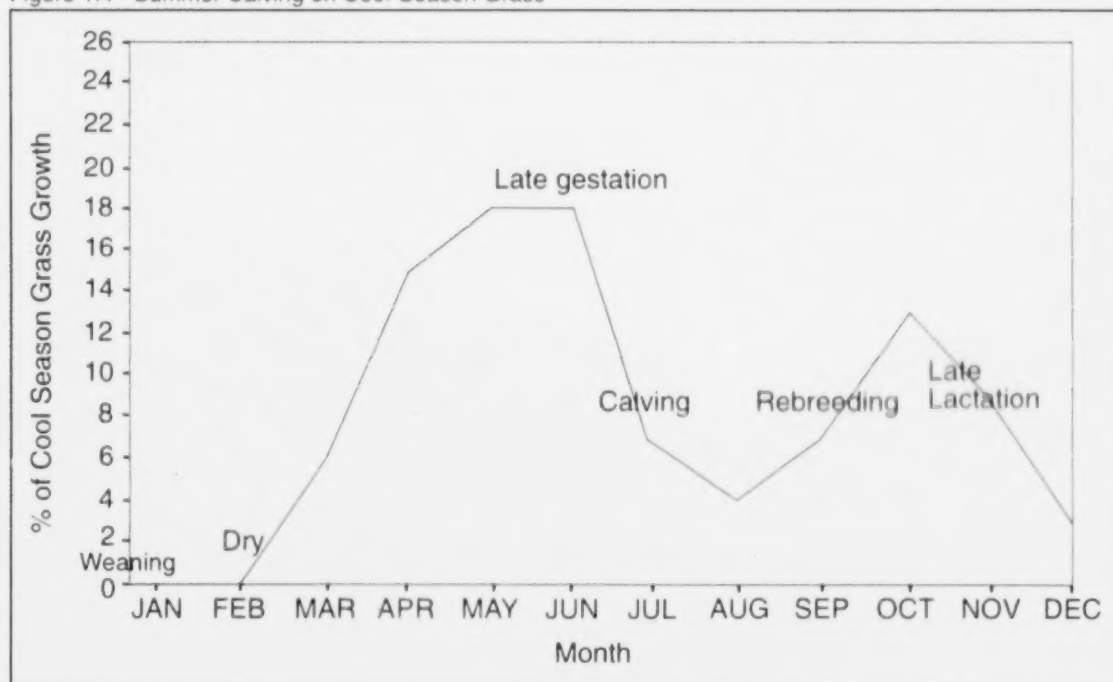


Figure 1.4 - Summer Calving on Cool-Season Grass



To calculate the forage dry matter intake requirements for a specific season, the pounds of dry matter needed per day are multiplied by the number of days in the season. For the above example, the seasonal dry matter intake requirements for spring (100 days) would be 110,000 lbs.

Summary

Understanding the nutritional needs of a livestock herd and how to meet those needs is the key to optimal production. Knowing the quality and quantity of forage needed for optimum livestock production allows the manager to make informed decisions concerning feeding practices. The

manager can then use the grasslands more efficiently to meet the nutrient requirements of animals.

Credits

Blakely, James, and David H. Bade. *The Science of Animal Husbandry*. 5th ed. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1990.

Coambes, Howard, John Jennings, and David E. Pitts. *Grassland Evaluation Contest Guide*. University of Missouri-Columbia: Instructional Materials Laboratory, 1998.

Lesson 2: Grazing Management Systems

The key to efficient livestock production is feeding and management. Grazing management combines these two elements. The way in which the forage is utilized will affect the profitability of a livestock operation. Knowing the needs of the herd and the potential of the pastureland will help the producer to determine which grazing system is best.

Methods of Harvesting

Forages are harvested by animals and by humans. Animals, both livestock and wildlife, eat forages by grazing. Two basic types of grazing systems--continuous and rotational grazing--are used for livestock. In continuous grazing, livestock graze on only one pasture unit. The animals are allowed to graze unrestricted throughout the grazing season. In contrast to continuous grazing, rotational grazing requires at least two grazing units. The animals alternate between the different pastures in a preplanned cycle. Strip grazing and management-intensive grazing are two types of rotational grazing. Each of these methods has its advantages and disadvantages. The best method to use depends on the grassland, animal needs, and management priorities.

One of the major differences between continuous and rotational grazing is selective grazing. In continuous grazing, livestock have unrestricted access to the pastureland throughout the grazing period. The animals can pick and choose the plants that they consume. In rotational grazing systems, however, the animals are only provided with the amount of forage they require for the grazing period. The animals feed on the plants in the area more evenly, because they are limited by the quantity of forage available.

Humans also harvest forages directly through mechanical harvesting for hay, silage, or green chop. The forage is cut and then stored to be fed later. This form of harvesting will be discussed in depth in the next lesson.

Continuous Grazing

The single pasture unit grazing system used in continuous grazing has the advantages of high initial performance and low maintenance. The high

performance of animals at the outset is due to their being able to selectively graze on the most palatable grasses and legumes and leave the less palatable and less nutritious weeds. The production weight of these animals will therefore be higher than that of animals that do not selectively graze. In addition, because only one pasture unit is utilized, continuous grazing requires less maintenance than rotational grazing systems, in which the herd is moved frequently.

The disadvantages of continuous grazing are the risk of changing the grassland composition and poor forage utilization by the herd. Whenever pastures are selectively grazed, the risk exists that the forage composition will be altered due to the overgrazing of quality forages. When these plants are grazed, other, less desirable plants are allowed to grow that may eventually shade the desired forages, either hindering their regrowth or killing them. Since the quality of a pasture that is being continuously grazed will quickly decline if it is overgrazed, this system is best used for areas that are only grazed for part of the year. In addition to changing grassland composition, the selective grazing that occurs in continuous grazing means that less desirable plants are not consumed by the animals, therefore decreasing the overall utilization of the forages available. The quality of forage that the herd eats will boost their production and increase gains, but production per acre will suffer because they are not using all of the plants available. Lower forage utilization results in lower carrying capacity.

Rotational Grazing

Rotational grazing requires more intensive management of pastureland and animals than continuous grazing due to the sequenced movement of the animals between two or more pastures or paddocks (smaller divisions of pastures). In rotational systems, the herd may be moved every one to thirty days. Movement of the animals is based on the rate of vegetative growth of the forage and the grazing intensity. Any grazing system based on management of forage availability, quantity, quality, and utilization is considered to be controlled grazing.

Rotational grazing has four main advantages for the producer. First, it helps to maintain the desired composition of the grassland. This form of grazing helps to reduce selective grazing of plants that are more palatable to the animals. A second advantage of rotational grazing is that this system allows for the

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regrowth of vegetation after grazing by providing rest periods for the grassland. These periods may last from ten to sixty days, depending on the rate of vegetative growth and the number of paddocks. Third, the rest periods decrease the amount of damage caused by compaction of the ground and animal wastes, because the time the herd is on the land is substantially decreased. Finally, rotational grazing allows more animals to be produced on a given area of pastureland, because more of the available forage will be utilized by the livestock. With a higher rate of forage utilization, production per acre is increased.

This grazing system has disadvantages as well. While production per acre is increased, the production weight of the livestock, or production per animal, may not be as high as that of animals that can selectively graze, although the livestock will still be of good quality. In rotational grazing, managing the herd requires much more time and labor than continuous grazing, since the animals are moved frequently. A rotational grazing system also requires extra fencing to separate the land into paddocks, increasing the costs to the producer.

Strip grazing is a type of rotational grazing system. In strip grazing, a large pasture is divided into strips with movable fences to control grazing. Paddocks are usually defined by a portable electric fence that allows the animals access to one to three days worth of forage. They have access to the areas that have been previously grazed as well as the fresh vegetation. The animals are grazed at a high stocking intensity (relative number of livestock per unit for fixed period). Strip grazing is used mainly for stockpiled forages during the dormant season.

Management-Intensive Grazing

Management-intensive grazing is another form of rotational grazing. The length of the grazing period is usually less than five days. The stocking rate in intensive grazing systems is increased, with the number of animals per unit area being greater than the other systems.

Advantages of intensive grazing include the maintenance of grassland composition and decreased damage from compaction and animal wastes. Because more animals are stocked and forage utilization is high, the production per unit area is even greater than in other grazing systems. Since the herd is moved frequently, the increase does not additionally harm the forage population. With its

short grazing periods, intensive grazing also provides for long periods of rest and regrowth. Another advantage is that the operator is in contact with the herd on a regular basis to identify and correct potential problems.

Disadvantages to using this system also exist. More time is needed to plan and set up the system. The pasture is divided into numerous paddocks, and the additional fencing increases costs. Production per animal may be decreased compared to animals allowed to selectively graze, although the large number of animals stocked in an intensive grazing system may make up for the loss per animal.

Grazing Efficiency

No grazing system is 100 percent efficient. In a pasture system, animal utilization of the forage is between 30 and 65 percent of what is actually grown. In continuous grazing systems, only 30 to 35 percent of the total forage produced is eaten by the livestock. When management intensive grazing is used, forage utilization can be as high as 65 percent of the forage produced.

To determine if forage availability is adequate for the herd, the efficiency of grazing must be considered. To calculate the actual amount of forage dry matter needed in a pasture to feed a herd during a particular season, the seasonal dry matter intake requirements should be divided by the forage utilization rate. For example, in a continuous grazing system with a herd that has a daily dry matter intake of 1,500 pounds and a season dry matter intake of 150,000 pounds, the amount of dry matter actually needed to feed the herd is 428,571 pounds ($150,000 \div .35$).

Grazing Intensity

Grazing intensity refers to the extent to which a plant or grassland is grazed. It is evaluated by looking at the height of the forage after grazing. The three levels of grazing intensity are heavy, moderate, and light grazing.

Heavy grazing, or overgrazing, exhausts the energy reserves of forages by removing growth too frequently, before it has a chance to replenish itself. Production declines, preferred plants are damaged, ground cover is reduced, and erosion begins. In cool-season grasses, heavy grazing is marked by the presence of less than four inches of growth in the fall. In warm-season grasses, anything less than

eight inches left at the end of the growing season would be overgrazing. Overgrazed fields typically have thin stands of vegetation, low forage vigor, and invading weeds or brush. The plants may appear short and weak.

Spot grazing is a form of overgrazing in which patches of pasture are grazed too frequently. Spot-grazing occurs during periods of active forage growth when livestock graze spots in a pasture while allowing other areas of the field to become mature and unpalatable. The livestock frequently regrow new growth in these spots because it is more palatable. Spot-grazed pastures have uneven forage heights and the forage in the grazed spots may become weak and thin.

Moderate grazing leaves enough vegetation to maintain the vigor of forage plants and protect the soil. Grass production remains high due to healthy root systems with substantial energy reserves. Cool-season grasses that are moderately grazed are four to eight inches high at the end of the season. Warm-season grasses have eight to ten inches of growth left. Moderate grazing generally results in pastures that are evenly grazed, with a uniform grazing height, thick stands, and good forage vigor.

Light grazing, or undergrazing, may not be beneficial if it results in too much tall, dense forage left in the fall. Excessive ground litter (accumulated plant parts on the soil surface) can interfere with the next year's crop. Cool-season grasses left taller than ten to twelve inches at the end of the growing season are considered lightly grazed. Lightly grazed warm-season grasses are more than twelve to fourteen inches high.

Carrying Capacity

Carrying capacity is the number of animals that a grazing unit can sustain throughout the grazing season. Factors that affect carrying capacity are annual forage production, seasonal utilization rate, average daily intake, and length of the grazing season. These factors are applied in the following formula.

$$\text{Carrying Capacity} = \frac{\text{Annual Forage Production} \times \text{Seasonal Utilization Rate}}{\text{Average Daily Intake} \times \text{Length of Grazing Season}}$$

Annual forage production is the amount of forage dry matter produced per acre (lbs./acre) during the year.

Seasonal utilization rate is the percentage of the forage produced that will be consumed by the herd in one year. This figure will vary according to the length of the grazing period.

Average daily intake is the percentage of the animal's body weight that will be consumed in forages on a daily basis (lbs. forage/lbs. live weight). Because it is an average, this figure may vary from animal to animal. It is determined by the performance class of the animal, as described in Lesson 1 of this unit.

Length of grazing season is the number of days per year that the herd's nutritional needs are met through grazing.

Suppose the annual forage production for a particular grazing unit is 7,000 lbs. of forage per acre. With a fifteen-day rotation period, the seasonal utilization rate is 60 percent. The average daily intake for the heifers that will use that paddock is 3 percent. It is grazed from April 1 to September 30, or 183 days. The carrying capacity is 765 lbs. live weight/acre.

$$\frac{7,000 \text{ lbs./acre} \times .60}{.03 \text{ lbs./lb. live weight} \times 183 \text{ days}} = 765 \text{ lbs. live weight/acre}$$

Timing of Grazing

Grazing time is determined by the stage of growth, not the calendar. The time of harvest will therefore vary slightly by plant species and may also vary within a plant species due to environmental conditions and management practices.

The goal of grazing is to keep the forage in the vegetative (leafy) stage, when forage growth is continuous and nutritional quality is high. The vegetative stage ends when plant reproduction begins. Plant growth occurs in four stages. They are referred to as the vegetative, boot, heading, and mature seed stages in grasses. In legumes, they are the vegetative, bud, bloom, and mature seed stages.

Grazing's Effect on Wildlife

Because grazing changes the quality and quantity of plants in the grassland, wildlife is affected by grazing livestock. Continuous grazing does not benefit wildlife because it depletes the amount of food and protection available. However, special provisions such as brush piles and fence lines with

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tall vegetation may aid wildlife. In contrast, rotational systems provide food and habitat for wildlife while forages are growing. They favor more diversity in grassland composition, which improves the food and cover available to wildlife. Rotational grazing systems also tend to protect wildlife habitat found in woody draws and along bodies of water by restricting livestock from these areas.

Cool-Season Grasses, Warm-Season Grasses, and Legumes in Grazing Systems

Using cool-season grasses, warm-season grasses, and legumes in a grazing system can be very beneficial. Doing so can improve overall quality of forages and increase livestock carrying capacity. Ideally, one-third of a producer's grazing system should consist of warm-season grasses. These grasses, such as big bluestem, eastern gamagrass, and indiangrass, begin the bulk of their growth around June and July, just when cool-season grasses like tall fescue and orchardgrass are finishing their spring growth. Legumes like red and white clover can lengthen the grazing season of cool-season grasses because they will often grow longer into the summer than the grasses do. They will also provide higher quality forage, fertilize the ground (through nitrogen fixation), and increase yields. As warm-season grass production declines after growth peaks in August, cool-season grasses reach another peak in forage growth during early fall.

Benefits for Wildlife

A grazing system of cool- and warm-season grasses and legumes can also provide wildlife with a more diverse habitat. By the time warm-season grasses are ready to be harvested (hayed or grazed), most grassland species of wildlife are finished using them for reproduction. At this time, the cool-season grasses are being rested, and wildlife can then use them for cover or nesting if necessary.

Summary

Grasslands may be harvested through grazing or mechanical harvesting. Rotational and continuous grazing are two types of grazing systems. Continuous grazing is a grazing system in which the herd remains in one pasture for the majority of the grazing season. Rotational systems, such as strip grazing and intensive grazing, involve movement of the herd between two or more pasture units. Movement is based on the rate of growth and

grazing intensity. The carrying capacity of a particular pasture is determined by annual forage production, seasonal utilization rate, average daily intake, and length of grazing season. The quality and quantity of forages is optimized if harvest occurs during the second stage of plant growth. Rotational grazing is the best system for maintaining wildlife habitat. A grazing system that combines cool-season and warm-season grasses and legumes benefits both livestock and wildlife.

Credits

Coambes, Howard, John Jennings, and David Pitts. *Grassland Contest Evaluation Guide*. University of Missouri - Columbia: Instructional Materials Laboratory, 1998.

Emmick, Darrell L., and Danny G. Fox. "Intensity and Timing of Grazing." *Prescribed Grazing Management to Improve Pasture Productivity in New York*. <http://www.scas.cit.cornell.edu/forage/pasture/intengraz.html> (7 May 1997).

Hermel, Shauna Rose. "Calculating Grass Needs." *Beef* 32 (1996): 16-17.

Rayburn, Edward B. "Principles of Grazing Management." <http://www.caf.wvu.edu/~forage/5710.htm> (8 May 1997).

Vallentine, John F. *Grazing Management*. San Diego: Academic Press, 1990.

Lesson 3:

Harvesting and Storing Forage Crops

The goal of livestock management on a grassland is to provide the best quality forage at the most reasonable cost. When the grassland is unable to provide for the nutritional needs of the herd, supplemental feeding is needed to sustain the animals. The most cost-effective method of supplemental feeding is to harvest and store the forage from the grassland when it exceeds the amount required by the herd and then feed it when needed later. High quality stored forages allow livestock operations to cut costs on supplemental feeds. This lesson will discuss the different methods of harvesting and storing forages.

Why Mechanically Harvest Forages?

As discussed in the previous lesson, grazing best meets the nutritional needs of the herd while the forage is in the vegetative state. If the grassland is providing more forage dry matter than the herd can use at the time, harvesting and storing the forage will keep the forage in the vegetative state and preserve the quality of the forage for later usage. Forage utilization will also be optimized by harvesting when the grassland is producing more than is needed by the herd, which maximizes the yield of the forage. The stored forage can be used to meet the nutritional needs of the herd when pastures are dormant. Finally, some producers sell the harvested forage for profit if it is not needed by the herd.

Methods of Mechanical Harvesting

Two main methods of mechanical harvesting provide feed for livestock--harvesting for hay or harvesting for silage. The forage is cut or chopped and then cured to produce hay or silage.

Hay is harvested at low moisture levels. Although many forages may be cut for hay, alfalfa is most commonly used. Hay can be grown on rough and rolling land that is unsuitable for many crops. The forage is cut and cured by allowing it to dry before being stored. The cutting and curing of hay is important. Too much or too little moisture can affect its quality. Wet weather, for example, can cause a considerable decrease in quality between cutting and drying the hay. When dry, hay can be stored

inside or outside, but protection from the wind and rain will help to preserve its quality.

Silage is forage converted into moist, succulent livestock feed through fermentation. Corn is most commonly used for silage. The forage is cut when moisture is high, wilted to a 60 to 70 percent moisture content, and then cut or chopped into smaller particles. The silage is cured by fermenting it in its storage structure. Additives can be included to increase its feed value or maintain its quality. Silage can be kept for two or more years if properly stored.

Storage Methods

Hay may be formed into square bales, round bales, or stacks and then stored in a barn, under temporary cover, or in the field, depending upon the resources available and the size of the bales. The better the quality of the hay, the more important it is to place it under cover. The higher the quality, the faster the hay will rot without protection.

Barns provide the best protection from the wind and rain. Temporary covers of black polyethylene, canvas, or nylon, which prevent water penetration, are sometimes placed on hay stored in the field in large round bales or loose stacks. Covers are an inexpensive form of protection from the wind and rain. The cheapest form of storage is leaving the hay in the field. However, the hay can undergo excessive loss of quality from wind, rain, and sun.

Silage is stored in silos to prevent spoilage and quality loss through the leaching of nutrients. These silos may be either vertical or horizontal. Vertical silos have several benefits. Storage losses are relatively low for all vertical silos. They can be located near the livestock and easily adapted for automated feeding. The two types of vertical silos are the conventional silo and the oxygen-limiting silo. Conventional silos are made of metal, concrete, or tile. Oxygen-limited units are sealed or lined with fused glass. This difference increases the cost per cubic foot but decreases storage losses.

Horizontal silos are much easier to construct and cost less than vertical silos. However, more leaching of nutrients occurs than in vertical silos, and horizontal silos should therefore be located on well-drained land to reduce spoilage. Due to their construction, the silage in horizontal silos also requires extensive packing, or tamping down with heavy equipment. Three different types of

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horizontal silos are used--bunker, trench, and stack silos. Bunkers are constructed above ground and have concrete floors and concrete or plank walls. Trench silos are dug into well-drained ground or hillsides. The walls and floor may be either soil or concrete. Stack silos are used only for temporary storage or emergency situations. They have no walls and may or may not have a concrete floor. The silage is formed into a pile and compacted. The lack of walls and floor increases spoilage losses greatly, so the silage should be used as soon as possible.

Factors Affecting Forage Quality

Several factors may affect the quality of stored forages. The moisture content of hay and silage can affect its quality. If hay is too moist, it will become moldy. If hay is too dry, leaf loss will occur due to dry and shattered leaves. Silage will become moldy if it is too dry. A reduction in quality may also occur in storage due to improper storage or lack of protection from the environment. A third factor affecting quality is the species composition of the forage. Different species of plants have different storage qualities as well as different palatability and nutritional benefits to livestock. Finally, as discussed in the previous lesson, the quality of the forage depends greatly on its stage of growth when harvested. As a forage reaches maturity, its quality is decreased as reproductive growth starts.

Stage of Growth at Harvest

As discussed in the previous lesson, plants pass through four stages of growth. Plants should be in the boot (grasses) or early bloom (legumes) stage at harvest. The time of harvest depends on the vegetative growth. Quality (digestibility) and quantity are in an inverse relationship. As maturity and quantity increase, quality decreases.

Sometimes a producer may sacrifice quality to increase the quantity of the forage harvested.

Summary

The harvesting and storage of forages is a crucial component of livestock management. Forages may be harvested as hay or silage, which may be stored in a number of different ways. Moisture content, storage method, and time of harvest all affect the quality of stored forage crops. The time of harvest depends on the vegetative growth during the boot or early bloom stage of growth.

Credits

Barnes, Robert F., Darrell A. Miller, and C. Jerry Nelson. *Forages, Volume I: An Introduction to Grassland Agriculture*. 5th ed. Ames: Iowa State University Press, 1995.

Hannaway, D. B., and P. J. Ballerstedt. "Testing the Quality of Alfalfa Hay." <http://www.forages.css.orst.edu/Resource...Publications/Species/Alfalfa/PNW223.html> (7 March 1997).

Rider, Allen, and Stephen Barr. *Fundamentals of Machine Operation: Hay and Forage Harvesting*. Moline, Ill.: Deere and Company, 1976.

Smith, Dale, Raymond Bula, and Richard Walgenbach. *Forage Management*. 5th ed. Dubuque, Iowa: Kendall/Hunt, 1986.

Trotter, David J., and Keith D. Johnson. "Forage Testing: Why, How, and Where." <http://www.css.orst.edu/Topics/FQT/Publications/Forage.html> (17 March 1997).

Walton, Peter D. *Production Management of Cultivated Forages*. Reston, Va.: Reston Publishing Company, Inc., 1983.

Lesson 4:

Wildlife Management

Managed grasslands have room for both wildlife and livestock. Both depend on grasslands to be in good condition to supply their needs. Modern management practices can improve most Missouri grasslands enough that both livestock production and wildlife habitat will increase.

Wildlife of Missouri's Grasslands

Many kinds of wildlife use grasslands, and each has different needs at different times. Some animals depend entirely on grasslands for all their needs. Greater prairie chickens, upland sandpipers, and meadowlarks are so adapted to grasslands, they can live virtually nowhere else. They require large open grasslands to survive. Rabbits, quail, and pheasants depend on grasslands extensively for food and cover but also need other habitat, like brushy cover. Deer and turkeys use grasslands when available but can survive in other habitats if grasslands are not within their range. Some amphibians require seasonal wetlands within a grassland, while some reptiles need rocky outcrops. A well-managed grassland will result in healthy streams and ponds for fish habitat. All these different types of wildlife depend on the people managing the land to maintain habitats for their survival.

Wildlife Needs

While the specific needs of each type of wildlife vary, the three basic components that determine wildlife habitats are water, food, and cover, as discussed in Lesson 4 of Unit 1.

Water - Missouri has plentiful rainfall, many rivers and streams, and plants that produce succulent foliage and fruits, all of which are natural sources of water for wildlife. Additional water sources can benefit wildlife, especially during drought. For example, farm ponds are common throughout the state. Water supplies developed for livestock are generally adequate for wildlife, with a few precautions. Water tanks accessible to wildlife should have a way for small animals to escape. It also helps to provide access points and perches so animals can get to water safely.

A bigger concern is controlling livestock so they do not damage water supplies. Unlimited access to streams and ponds allows animals to congregate and destroy bank vegetation, cause erosion, degrade water quality, and spread disease. Producers should restrict livestock to certain points of access where damage will be reduced and rotate between locations so no part of the shoreline is overused. A better option is to provide separate watering facilities supplied by a pond or stream but away from these sensitive areas. Stock watering tanks below dams and mechanical and solar watering devices improve the availability and quality of water for livestock and allow the pond or stream to be fenced off. Assistance and cost-sharing may be available through the Natural Resources Conservation Service (NRCS) and the Missouri Department of Conservation (MDC).

Food - The grassland food chain begins with forage plants that produce green browse and seeds and provide a home for insects. Quail, prairie chickens, and pheasants require seeds in their diet. Insects are a major part of the diet of many birds and mammals, especially young game birds. Rabbits eat vegetative parts of grasses, legumes, and forbs.

A single pasture or grassland over-utilized by livestock may not have enough forage and seed for wildlife, but wildlife are not restricted to that area. This makes land next to a pasture critical to the carrying capacity for wildlife. Leaving a few rows of grain sorghum, corn, or sunflowers along the edges of nearby crop fields can provide standing grain. One-acre grain food plots can be planted in odd areas and left standing for wildlife. Grassy areas along the edges of fields, fencerows, waterways, roads, terraces, and dams, along with pastures being rested, can be allowed to go to seed. All these areas should be protected from livestock grazing.

Producers should arrange to supply food for wildlife during winter. Fall plowing buries seeds and crop residues and should be avoided whenever possible. Snow and ice can also bury foods, so leaving standing seed heads of grasses and grains can be beneficial to wildlife. Fruits of trees and shrubs are also very important to wildlife survival during winter.

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Cover - The need for cover varies with the wildlife species and season. Cover is important for protection, nesting, and roosting. Food must be near suitable cover, and wildlife should be able to walk through good cover to their feeding grounds. Wildlife use four types of cover: soft cover, shrubby cover, hard cover, and escape cover.

Soft cover is the nonwoody growth of grasses, legumes, and forbs. This cover needs to be at least eight inches tall to be of value to most wildlife. Grassland birds depend greatly on soft cover. They need a canopy of grasses and forbs overhead to hide from predators and shield them from harsh weather; they also need open spaces between plants at ground level where they can scurry around finding seeds and insects. Native warm-season grasses provide the best soft cover. As bunchgrasses, they have the perfect combination of an overhead canopy with openings below for travel lanes. Most cool-season grasses are sod-forming grasses that lack these lanes.

Shrubby cover consists of woody brush and shrubs with multiple stems growing from a common base that are generally less than twenty feet tall. It provides shelter and concealment for many animals. When growing close together in a thicket, it also supplies escape and nesting cover. Shrubby cover produces browse for deer along with seeds and fruits for other wildlife.

Hard cover consists of trees and shrubs twenty or more feet tall. This type of cover is beneficial for deer, turkey, and many songbirds. Seeds, fruits, nuts, and acorns are important foods provided by hard cover.

Escape cover is especially dense shrubby or hard cover where wildlife can escape predators. For example, a rabbit or quail would use it to get away from foxes, coyotes, and hawks. This dense "brush" is often found in areas next to grasslands and should always be protected from grazing. If escape cover is scarce, producers can construct brush piles from limbs left from firewood cuttings or from the thinning of trees along the grassland edge to reduce competition from shading.

Producers should manage the shrubby, hard, and escape cover on their land. The cover in woody draws, brushy fence rows, and adjacent woodlands should be protected and fenced to prevent grazing. Where woody or shrubby cover is lacking, planting may be needed. Seedlings are available through the MDC's state nursery for a nominal charge. Occasionally, good wildlife management will require the removal of woody vegetation when woody plants are invading grasslands. Their removal improves the overall balance of the grassland habitat for specific wildlife needs.

Factors Affecting the Value of Grasslands for Wildlife

The characteristics of a grassland affects what kind of food and cover it provides. To manage a grassland for any particular wildlife species means creating the habitat that most closely meets that animal's needs. Another approach to managing grasslands is to create a diverse habitat that will meet the needs of a variety of wildlife. Four factors usually determine how valuable a grassland is for wildlife--the type of grassland, composition of the grassland, use of the grassland, and size of the grassland or pasture unit.

Type of grassland - Each species of grass has its own growth characteristics. Depending on their abundance in the grass stand, the plant species that are present will influence the habitat provided for wildlife.

Cool-season pastures are dominated by nonnative, sod-forming grasses such as tall fescue, Kentucky bluegrass, and brome grass. These grasses are often harvested for hay at the height of the nesting season, which creates problems for ground-nesting birds like bobwhite quail.

Native warm-season pastures are dominated by native bunchgrasses such as big bluestem, indiangrass, sideoats gramma, little bluestem, and switchgrass. Although warm-season grasses have a shorter growing season, they use water and soil nutrients more efficiently than other grasses. They generally provide better food and cover when properly managed. They are not ready for haying until midsummer, when most

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ground-nesting wildlife have produced their broods.

Native grasslands (remnant prairies) are dominated by a mixture of native warm-season grasses with a good complement of native legumes and forbs. The plant species may number into the hundreds, attracting many species of wildlife. In west, central, and north-central Missouri, remnant prairies are vital to the survival of the prairie chicken.

Plant composition - Grasses are the main plants in a grassland, but a variety of plants generally makes the grassland more productive and improves wildlife habitat. A mixture of vegetation improves the quality of cover and the available food supply. Two or more grasses generally provide a more rounded diet for livestock and wildlife. Legumes and forbs that produce seeds are also a very important part of the diet of many wildlife species. Flowering plants are important to insects, which in turn are needed for pollination and seed production. A diversity of plants attracts insects important in the food chain supporting wildlife. The more types of broadleaf and seed-producing plants there are, the more value a field has for wildlife. If too many of these plants are removed, the number of animals the area can support will also be reduced.

Size of the grassland - To provide suitable habitat, food, cover, and water must all be found in an area that a particular species can use. Depending on its size, a grassland may or may not support certain kinds of wildlife, since different species require grasslands of different sizes. A 100-acre grassland can support many butterflies on just a partial acre if it has an abundance of their preferred flowers and food plants. A collared lizard occupies a small area in a glade, but an entire population of lizards needs 10 acres or more. A covey (small flock) of quail will range over 20 to 40 acres to meet their needs; a grassland 100 acres in size will be more valuable to them if it is broken up by woody draws, fencerows, edges, and crop fields. Deer may range over an area twice that size or larger and can do quite well if bordering areas have plenty of woody and brushy areas. Prairie chickens require a nearly pure grassland with few trees and shrubs interrupting the landscape and

would fare better if neighboring fields were also primarily grassland.

Use of the grassland - When and how grass is harvested is probably the most critical factor affecting the value of a grassland for both wildlife and livestock. Haying removes food and cover in one sudden operation. Grazing removes vegetation more slowly; the rate at which it is removed depends on the grazing period and stocking rate, or number of livestock on the grassland.

Grassland Management Practices

Management is necessary to keep grasslands productive. When left idle for too long, grasslands lose productivity as ground litter builds up and woody species invade. Management practices include grazing, haying, fertilizing, overseeding with legumes, irrigation, reestablishing native warm-season grasses and forbs, and prescribed burning.

Grazing - Overall, cool-season grasses can be grazed shorter than warm-season grasses, which gave early grassland managers the misconception that cool-season grasses are more productive and better for forage operations. In reality, they were simply managing warm-season grasses improperly. The most productive grassland operations today feature warm-season grasses in many of their pastures.

Of the two types of grazing, continuous grazing is less beneficial for wildlife than rotational grazing. Grazing intensity is hard to control under continuous grazing. Even when stocking is correct, animals may seriously overgraze certain areas before moving to others and thus eliminate the palatable plants that are the most valuable for wildlife. It also leads to soil erosion, decreases wildlife food and cover, and disturbs birds during nesting. Rotational grazing allows managers to move livestock when necessary to maintain the grassland. It gives the valuable palatable plants a resting period in which to grow and multiply. This type of grazing gradually results in increased livestock production, reduced soil erosion, conservation of water and soil nutrients, and improved wildlife food and cover.

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The timing of grazing is critical to wildlife, and rotational grazing allows it to be timed to benefit both livestock and wildlife. Livestock can disturb birds during courtship and trample their nests. Grazing can also remove the top growth before most plants have gone to seed. Producers can schedule prime nesting areas for rest periods when wildlife need them. They can arrange to have livestock graze next to nesting areas so chicks will have access to open ground with a different mix of foods next to good soft cover. Paddocks next to woody cover or other wintering grounds can be scheduled for grazing early in the season so they can regrow cover and seed to help wildlife through the winter.

A moderate grazing intensity is the most beneficial level of grazing for wildlife. In heavy grazing, little vegetation is left for wildlife cover or food, while light grazing can leave dense forage that hinders the movement of small wildlife like game birds. Moderate grazing provides adequate food and cover. Grazing at this level opens travel lanes between plants and creates some bare ground for seed gathering and dusting areas (areas where birds can stir up dust to get rid of mites).

Mechanical harvesting - Many of the same considerations for grazing apply to mechanical harvesting. The main difference is vegetation is removed in one operation. Such sudden changes in habitat are hard on wildlife. On the positive side, the equipment is more precisely controlled than livestock.

Grassland managers can adjust location, timing, and mowing height to leave enough food and cover as needed. To reduce the impact of haying, the recommended practice is that the outer thirty feet of hayfields be left standing or be cut later. Another beneficial practice is to have a balance of warm- and cool-season pastures with different harvest dates so areas of food and cover are always available for wildlife. Staggering haying schedules so harvest takes place over a longer period can also benefit wildlife.

Fertilizing - Only well-managed pastures benefit from fertilizer and liming. If grasslands are overgrazed or otherwise in poor condition, weeds will be the first to benefit from using fertilizer.

Fertilizing can help wildlife if it increases grassland production and improves the nutritional quality of their food, but only if other management practices leave enough food and cover. Native grasslands do not usually benefit from fertilizing. In a healthy native plant community, fertilizer acts as a foreign disturbance that can change plant composition and allow weeds to take over.

Overseeding with legumes - In pastures, seeding with legumes helps wildlife by adding diversity to the types of food and cover available. Legumes should not be added to native grasslands because these areas already contain legumes and forbs more suitable to the site. Overseeding may disrupt the composition of the natural community and could introduce weeds. Overseeding is described in more detail in the next lesson.

Irrigation - Irrigated pasture is not widely used in Missouri, though it may become more common as the economics of intensive forage production continue to develop. Irrigation should benefit wildlife as an additional source of water, especially in times of drought. It could harm wildlife if production required irrigating during critical times such as the nesting season, while small chicks are in the field, or when it might make wildlife more susceptible to weather extremes. This seems unlikely in Missouri, but all factors should be considered in planning any management practice to make sure it is truly beneficial to the overall grassland operation.

Reestablishing native warm-season grasses - Most of Missouri's grasslands have been converted to fescue or a mixture of cool-season grasses with fescue dominating. Landowners can improve seasonal forage production and help wildlife by converting a portion of this cool-season pasture to native warm-season grasses. These grasses are the plants to which the wildlife have adapted, and they are best at fulfilling most needs for food and cover.

Prescribed burning - Prescribed burning is being recognized as a prime tool in maintaining native warm-season grasslands. It helps in maintaining a vigorous grassland community; for example, it can maintain or increase the native legumes used by wildlife. Training, advance planning, and

extreme care are needed to use fire safely. A more detailed discussion of the use of prescribed burning is given in Lesson 5.

Evaluating Existing Wildlife Habitat

The first step in incorporating wildlife management into a grassland management plan is to assess the grassland to figure out its usefulness for rabbits and quail. Several factors must be examined when looking at wildlife habitat to decide how it can be improved for these species. The criteria used to evaluate grasslands may be different for other species.

Extent of the border - The border refers to herbaceous, grassy, or woody (brush, windbreaks, hedgerows, etc.) strips of vegetation between habitat types. The strip must be a minimum of five feet in width to be of value to wildlife. To evaluate a border, the vegetation change must exist within the fenced area of the grassland being evaluated. Habitat components in adjacent fields will be evaluated separately within that field.

Percent of field covered by winter or escape cover - Winter and escape cover is very important to the survival of rabbits and quail. It includes dense brushy cover, brush piles, fallen logs, etc. To be of value, the cover must be dense enough that a human would have great difficulty walking through it, and a coyote or fox would be unable to catch a rabbit that ran into it.

Percent canopy coverage of shrubs and herbaceous vegetation 6 to 18 inches tall - Canopy cover provides protection from birds of prey (or aerial cover) while allowing easy movement through the vegetation. It consists of shrubs and weedy plants that are from six to eighteen inches tall, or around knee high. The ideal range of canopy cover for quail and rabbits would be between 26 and 75 percent. When canopy coverage is less than 25 percent or more than 75 percent, the area is considered less attractive to upland wildlife, especially rabbits and quail. For example, an area with more than 75 percent coverage may be difficult for them to walk through.

Grazing pressure - The height of the grass or forage is a critical factor for wildlife such as rabbits and quail. During the growing season, quail may use the field edges for nesting but will be forced to move to other sites if the livestock graze plants to less than

eight inches. Quail nests can also be trampled and destroyed by livestock in pasture units with heavy grazing.

Light grazing may result in tall forage being present on the unit during most of the year. Too much forage could be present for rabbit and quail. Very dense grassy vegetation, especially fescue, can restrict the ability of young quail to range away from the nest.

Moderate grazing refers mainly to a cool-season pasture and is defined as leaving three to six inches of growth during the winter. For native warm-season grasses, only 50 percent of the year's growth should be removed through grazing. These grasses should not be grazed to a height of less than eight inches. Livestock should never be allowed to "winter" on any native warm-season grassland.

If a cool-season grass pasture has a history of heavy grazing, all grazing should be deferred during the growing season to improve the vigor of the grass stand. Deferral will also improve plant composition. After a period of rest, the stand can be grazed, but it should be monitored closely to avoid the removal of too much of the forage.

Percent of ground covered or shaded by legumes - Legumes are an important plant group for both wildlife and livestock. They include alfalfa, clovers, tick trefoil, Korean lespedeza, partridge pea, lead plant, hop clover, and many others. Wildlife use both the seeds and the vegetative parts of legumes. These plants are also important in removing nitrogen from the air and fixing it in the soil for use by other plants, including grasses and forbs. Insects that make up a high percentage of the diet of quail and songbirds can also be found on these plants. Rabbits and quail find grazing units with less than 5 percent or more than 50 percent of the ground covered by legumes to be less attractive than when the ground cover ranges between 6 and 50 percent.

Plant composition - A field that is more than 90 percent tall fescue is not beneficial to wildlife. The stem density at ground level would be too thick to be attractive to wildlife. Most species would avoid an area for nesting and other purposes when fescue approaches 40 percent of the plant composition.

Pastures with mixed cool-season grasses are common in Missouri, but legumes do not make up enough of the plant population in these pastures to

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be attractive to wildlife. The grasses could include a mixture of orchardgrass, fescue, and bluegrass.

In some pastures, cool-season grasses are dominant, with legumes making up only a small percentage of the composition. The dominant grass could be tall fescue, orchardgrass, timothy, etc.

Areas with cool-season grass and 26 to 60 percent legumes are usually considered to be cool-season/legume pasture. These grasses could be a mixture of fescue, orchardgrass, and bluegrass, with legumes such as clovers and lespedezas. This forage system is probably the most widely used system in Missouri. The grass and legume mixture is attractive to insects that make up nearly the entire diet of young quail chicks that have just left the nest in search of food.

Pastures where legumes are dominant are excellent for turkey poults, quail chicks, and many songbirds, which can easily move through the vegetation in search of insects and succulent plants for food. Deer, rabbits, groundhogs, and small rodents also find these areas attractive as a source of food and cover.

A grassland in which native warm-season grasses are dominant provides an excellent habitat for most wildlife species when managed for other necessary habitat components as well. These grasses provide a cool, moist summer environment and a warm, dry winter environment. They are compatible with the legumes, sedges, and seed-producing forbs, which are used as browse by wildlife species. Insects, which are important in the diet of many wildlife species, thrive in the native bunchgrasses and feed mainly on the legumes and forbs. A mixture of broadleaf plants and grasses provide the diversity required by ground-nesting birds such as quail and many songbirds. It should be noted that not all introduced (nonnative) warm-season grasses provide an attractive habitat after they have become established. They most often form a dense sod that eliminates or restricts wildlife movement.

Distance from center of field to edge of nearest crop field - Studies show that crop fields are an important part of the habitat of bobwhite quail. If a minimum amount of pesticides is used, soil disturbance produces ragweed and other seed-producing plants that are important quail foods. Crop residues (waste grain) left on the soil surface after harvest can be an important source of food during the winter.

Studies also show that a large number of bobwhite quail nests are found within 50 to 150 feet of bare ground. If bare ground, such as a crop field, is next to a properly managed grassland, the chance of a pair of quail successfully hatching and rearing their brood of young chicks is greatly increased.

When evaluating a grassland, the distance from the center of the grazing unit or paddock to the edge of the nearest crop field should be estimated. A crop field that is more than 500 feet from the center of the grassland unit is considered to be of no value to upland wildlife like rabbit and quail. A crop field with no fall tillage that is found less than 250 feet from the center of the pasture is considered to be of the highest value.

Percent of grazing unit that is within 250 feet of dense woody cover or ungrazed woodland - Generally, the larger the field, the less value it has for wildlife. Quail use the field edge where other habitat types, especially escape cover, are available. Studies show that quail rarely move farther than one-eighth of a mile (660 ft.) between habitat components. Cottontail rabbits require habitat components that are even closer together--250 feet. The interior of a very large grassland grazing unit would therefore be used very little by these wildlife species.

In evaluating the grassland, the percent of the field that is located within 250 feet of concealment cover, ungrazed woodland, or dense woody cover should be estimated. Generally, this area represents that portion of a pasture or hay field that quail and rabbits will use during average seasonal conditions.

Management Plans for Rabbits and Quail

Just as producers can make plans for managing livestock on a grassland, they can also make plans for the wildlife that live there. Management plans for wildlife can be designed to benefit any species. Usually, they are written for rabbits and quail. One reason is that both rabbits and quail are popular game animals. They also require a relatively small acreage, so good wildlife management plans can be written for both large and small farms. A more important reason is that the habitat needs of these species are similar to those of a variety of other species. Rabbits and quail are referred to as indicator species because if a habitat benefits them, many other species will

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prosper. They can therefore indicate the usefulness of a grassland for wildlife.

Summary

Producers can manage grasslands to accommodate the needs of livestock and many different kinds of wildlife. The basic requirements for wildlife habitat are water, food, and cover. Four characteristics of grasslands affect how they meet these requirements: type of grassland, plant composition, use, and size. Producers need to take these characteristics and the needs of wildlife into account when carrying out

grassland management practices like grazing and haying. As they develop a grassland management plan, they need to look at the quality of the grassland for wildlife to decide where improvements can be made. Producers may also adopt wildlife management plans to manage their grassland for a particular species.

Credits

Pitts, David E. *Private Land Wildlife Management for Missouri Landowners*. Jefferson City: Missouri Department of Conservation, Wildlife Division, 1991.

Lesson 5:

Grassland Management Plan

This lesson will show how a grassland management plan is developed to build a profitable livestock operation. The information covered in previous units will be incorporated in the plan through the management decisions made for the livestock operation.

Components of a Grassland Management Plan

Certain management tools are needed to run a profitable livestock operation. They include soil test results, soil identification information, maps, a knowledge of plant composition, information on livestock needs, and a herd inventory. Each of them provides information needed for a grassland management plan.

Soil test results provide information on the current condition of soil fertility. Soil tests are used to determine what amendments should be made to the soil in order to increase the quality and yield of the forage.

Information on soil identification can be found in soil survey manuals. The type of soil will affect the drainage and use classification of a particular grassland.

Maps in the soil survey manual will make it possible to determine where a type of soil is located in the pasture. Maps provide a visual representation of the land that shows its physical layout, including water, slope, and drainage.

Plant composition is the current quality, quantity, and variety of forage plants found on a given plot of land. A knowledge of plant composition will help to determine the best grazing system and carrying capacity for a grassland.

Livestock needs are determined by their species, age, sex, production level, and environment. This information represents the nutritional needs of the animals at any given time.

A herd inventory reveals the quantity of animals in the different production classes discussed in Lesson 1 of this unit. Production is optimized if the total nutritional needs of the herd are met by the grassland without any waste or shortage of feed.

Developing a Grassland Management Plan

Developing a grassland management plan (GMP) involves several steps. One of the first steps in developing a grassland management plan is to acquire an aerial photograph of the grassland. On the map, outline the field included in the GMP. Soil tests should then be completed for each field. A complete grassland inventory looking at plant composition must also be conducted to help the grassland manager determine the quality and quantity of pasture available and assist in calculating stocking rates.

Wildlife needs are another factor to be considered in a grassland management plan. A successful GMP can provide for both wildlife and livestock. Assistance for creating a wildlife management plan is available from the Missouri Department of Conservation.

After these steps have been completed, a grassland management plan must be selected. Possibilities for grazing are endless, and the grazing system chosen depends on the individual's situation. For example, a dairy farm that requires high quality forage may have twenty paddocks and may rotate the herd twice a day. On the other hand, a small cow/calf producer could do quite well with only a three- to five-paddock system with longer rotation periods. The grassland manager needs to decide what areas should be grazed and which fields should be mechanically harvested for hay or silage.

Selection of Grazing Systems

The selection of a grazing method is based on the interaction between soil, environment, resources (such as time and labor), herd needs, wildlife, and plants. The goal when choosing a grazing system is to match the forages with livestock needs, but other factors may influence the choice of a grazing system. For example, the amount of labor available could determine how many rotations may be made or if a rotational system would be feasible. If there has been a drought, forages will decrease in yield, and supplemental feeding may be needed. Plant composition could lengthen the grazing season if the forages chosen have different growing seasons. Flexibility, intensive management, and a knowledge of plant and animal growth are the keys to profitable livestock management.

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Basis of Forage Selection

The two factors that determine forage selection are forage management and livestock management. The goal of forage management is to find a forage that will create a persistent stand and produce acceptable yields. It involves determining what will grow in the given climate and site conditions. Livestock management influences forage selection by looking at the nutrient needs of the livestock and the intensity of harvest or grazing needed to sustain the herd and reach the goal of profitable gains.

Of the two factors, forage management should be considered first. The fact that a particular forage can meet the needs of the herd is not important if the forage cannot grow in the grassland. A producer should determine what plant species will grow and then decide which of these plants will best meet the needs of the herd.

Maintaining and Renovating a Grassland

Several practices are commonly used to maintain or renovate a grassland. Renovating involves making improvements to promote renewed growth. Some methods for maintaining and renovating a grassland are outlined below.

Testing the soil and then amending it is a good practice. Learning the current conditions of the soil from the test results will indicate what changes need to be made to improve the soil. Spreading fertilizer or liming are two ways to amend the soil. Disking may also be used to amend the soil when maintaining the grassland.

In renovation, suppressing or destroying existing unwanted plants may be necessary to decrease competition. The grassland manager can use chemicals or machinery to get rid of unwanted plants. If chemicals are used, he or she should be aware of the safety precautions for humans and animals and always follow the instructions on the label. Machinery can also be used to disk or plow the surface to eliminate existing plants.

Most often, renovation of a grassland includes the introduction of legumes, which may be done by overseeding or no-till planting. In Missouri, the legumes most often used are white clover, annual lespedeza, red clover, and birdsfoot trefoil. They may also be used in combination with each other. Overseeding is accomplished by broadcasting legumes into an existing pasture in which the stand

is thinned or grazed close to the ground. This practice is usually carried out during late winter, which is sometimes called frost-seeding, or early in the fall. Overseeding can be one of the most effective methods of renovation if conducted properly and at the right time.

No-till renovation is accomplished with a no-till drill. The no-till drill is a piece of specialized machinery that can place the seed into the ground at an optimal depth without the ground being worked up (i.e., by disking or plowing). This practice is also sometimes used to establish additional grass. Some advantages of no-till planting are lower seeding rates, precise placement of seed, and reduction in the loss of valuable organic matter due to tillage. One of the greatest benefits of the no-till method is that soil erosion can be greatly reduced.

Prescribed burning is another way to renovate and improve the quality of grasslands. This practice is most commonly used for native warm-season grasses such as switchgrass, big bluestem, and indiangrass. Fire is used deliberately to remove the unwanted previous year's growth, keep invading woody plants in check, and reduce competition from invading cool-season grasses, such as tall fescue, bluegrass, and smooth brome grass. Burning is usually conducted in the spring. This practice encourages fast and vigorous growth right after the burn, since it releases nutrients that are locked up in the previous year's growth. Benefits from fire usually peak two to three years after the burn, and most native warm-season Missouri grasslands need prescribed burning every three to five years. Landowners interested in using prescribed burning to maintain grasslands must learn to use it safely. Training is available from the NRCS and MDC. When planning a burn, the grassland manager should contact the local NRCS office and local rural fire departments.

Summary

For a grassland management plan to be profitable, many aspects of production must be considered. An inventory of current conditions helps the producer to make educated choices about grazing systems, forage selection, and renovation plans.

Credits

Barnes, Robert F., Darrell A. Miller, and C. Jerry Nelson. *Forages, Volume I: An Introduction to*

Grassland Management Practices

Grassland Agriculture. 5th ed. Ames: Iowa State University Press, 1995.

Smith, Dale, Raymond Bula, and Richard Walgenbach. *Forage Management*. 5th ed. Debuque: Kendall/Hunt, 1986.

Walton, Peter D. *Production and Management of Cultivated Forages*. Reston, VA: Reston Publishing Company, Inc., 1983.

GLOSSARY

A

alternate: Leaf arrangement in which the leaf or bud is located singly at different heights alternating from side to side along the length of the stem.

annual: A plant that completes its life cycle within one year or growing season.

apex: The tip of a leaf.

auricle: Flaplike appendages that clasp the stem at the top of the sheath in grasses.

axillary bud: Buds found on the side of the stem in woody plants. Also called *lateral buds*.

B

basal: Leaf arrangement in which leaves are located at the base of the plant.

base: The bottom area of the leaf where the petiole connects to the blade.

biennial: A plant that requires two years to complete its life cycle.

bipinnate: Twice pinnate, with the primary leaflet being divided into secondary leaflets.

blade: The flat, large part of the leaf, containing leaf tissue, a midrib, and veins.

border: Herbaceous, grassy, or woody strips of vegetation between habitat types.

C

carrying capacity: The number of animals that a grazing unit can sustain throughout the grazing season.

cation exchange capacity (CEC): A measure of the soil's ability to hold positively charged nutrients called cations.

cations: Positively charged nutrients--calcium, magnesium, potassium, and hydrogen.

collar: On a grass blade, the external narrow band found where the blade and the sheath join.

compound leaf: A leaf in which more than one small leaf, or leaflet, grows from the same petiole.

continuous grazing: A grazing system in which livestock graze unrestrictedly on only one pasture unit for the majority of the grazing season.

controlled grazing: Any grazing system based on the management of forage availability, quantity, quality, and utilization is considered to be controlled grazing.

cool-season grass: Grass that grows best during the spring and fall, with optimum growth occurring when air temperatures fall between 59 and 77 degrees Fahrenheit.

cover: Vegetation that provides shelter and protection for wildlife.

culm: The stem of a grass.

D

drainage: The speed at which water moves from the soil surface.

dry matter: The total amount of matter in a forage minus any moisture it contains.

E

effective neutralizing material (ENM): Measure of the ability of limestone to reduce soil acidity.

erosion: The loss of soil by wind or water.

escape cover: Especially dense shrubby or hard cover in which wildlife can escape predators. See also **cover**.

F

forages: Plants, primarily grasses and legumes, grown for their soft vegetative parts, which are feed for livestock.

forb: A broad-leaved, herbaceous plant that is neither a grass nor a legume.

G

glabrous: Smooth and shiny.

glade: Small, isolated native grasslands that form on hilltops and southwest-facing slopes where rocky outcrops, exposure to sunlight, and thin, dry soils create harsh, desert-like conditions during the summer.

glaucous: Covered with fine, waxy, whitish bloom.

grass: A herbaceous plant with a hollow stem, leaf blades that connect to the stem at a sheath, and parallel-veined leaves.

grassland: 1. Ecologically, any plant community dominated by grasses, whether they exist naturally or because of management practices. 2. Agriculturally, areas managed to grow grass, legumes, or other pasture or range plants.

grassland composition: The quality and variety of plants that grow in a grassland.

grassland conservation: The wise use of grasslands and other natural resources found on them to ensure long-term productivity and sustainability.

grassland management: The use and care of grasslands.

grazing: A type of harvesting in which animals, both livestock and wildlife, eat forages.

grazing intensity: The extent to which a plant or grassland is grazed.

ground litter: Accumulated plant parts on the soil surface.

H

hard cover: Cover used by wildlife consisting of trees and shrubs twenty or more feet tall. See also **cover**.

hardpan: A dense layer of soil.

hay: Forage harvested at low moisture levels that is cured by allowing it to dry before storage.

herbaceous: Not woody.

herd inventory: An inventory of the quantity of animals in the different production classes.

I

indicator species: Species used to indicate the usefulness of a grassland for other wildlife; specifically rabbits and quail.

inflorescence: The arrangement of flowers on a plant.

internode: The distance between nodes in plants.

L

leaf scar: A mark found where a leaf was attached to the stem.

legume: A plant characterized by nodules with nitrogen-fixing capacity on most rooting systems.

lenticel: Breathing pores found scattered on the stem of woody plants.

ligule: The upright projection of tissue at the internal junction of the blade and the sheath in grasses.

M

managed grassland: Any area managed for forage, pasture, or grassland habitat.

management-intensive grazing: A form of rotational grazing with a grazing period that is usually less than five days and a high stocking rate. See also **rotational grazing**.

margin: The outside edge of the leaf blade.

N

native grasslands: Grasslands that existed in America before the arrival of European settlers.

neutralizable acidity: Measure of the reserve acidity of a soil, or its ability to remain acid.

nitrogen fixation: The ability to take nitrogen from the atmosphere and change it into a form of nitrogen that plants can use; the process is carried out by symbiotic bacteria in legumes.

node: 1. In grasses, the solid portion of the stem. 2. In woody plants, the joints from which leaves or branches grow.

no-till planting: Planting involving specialized machinery that can place seed in the ground at an optimal depth without the ground being worked up.

O

opposite: Leaf arrangement in which leaves are located directly opposite each other in pairs along the stem.

organic matter: Decayed plant material in the soil.

overgrazing: Heavy grazing that exhausts the energy reserves of forages by removing growth too frequently.

overseeding: The practice of broadcasting legumes into an existing pasture in which the stand is thinned or grazed close to the ground.

P

paddock: Smaller division of a pasture.

palmate: In leaves, all of the leaflets attach to the same point at the tip of the petiole.

palmate venation: Arrangement of veins in a leaf in which all of the main veins fan out from the same point at the base of the blade.

perennial: A plant that grows year after year.

permeability: The movement of air and water through the soil.

petiole: The stalk that connects a leaf to the stem.

pH: A numerical measure of the acidity of the soil.

pinnate: In leaves, a compound leaf that has a long stem, or rachis, to which the smaller leaflets are attached on both sides.

pinnate venation: Arrangement of veins in a leaf in which a midrib runs the length of the blade and smaller veins branch out from it.

prairie: Large, continuous native grasslands in which trees and shrubs are nearly absent.

prescribed burning: The deliberate use of fire to burn a grassland to achieve certain management objectives.

profile: Vertical section of the soil.

pubescent: Covered with hair.

R

rhizome: A modified stem that branches off from the main plant underground.

rotational grazing: A method of grazing in which animals alternate between two or more grazing units in a preplanned cycle. See also **strip grazing** and **management-intensive grazing**.

S

savanna: A specialized plant community intermediate between grassland and forest with widely spaced trees, a noticeable absence of small trees and shrubs, and grasses as the main ground cover.

selective grazing: A type of grazing in which animals pick and choose the plants they consume because they have unrestricted access to more forage than they require.

sheath: The part that encircles the stem and the bud shoot in grasses.

shrubby cover: Cover used by wildlife consisting of woody brush and shrubs with multiple stems growing from a common base that are generally less than twenty feet tall. See also **cover**.

silage: Forage converted into moist, succulent livestock feed through fermentation.

simple leaf: A leaf in which one blade rises from the petiole; it may be lobed.

slope: The steepness of the land's surface.

soft cover: The nonwoody growth of grasses, legumes, and forbs used by wildlife. See also **cover**.

soil series: Groups of similar soils.

soil texture: Relative proportions of sand, silt, and clay particles in soil.

spot grazing: A form of overgrazing in which patches of pasture are grazed too frequently.

stipules: Small leaf-like structures sometimes found at the base of the petiole.

stocking intensity: The relative number of livestock per unit for a fixed period.

stocking rate: The number of livestock on the grassland.

stolon: A modified stem that grows horizontally along the ground's surface.

strip grazing: A type of rotational grazing in which a large pasture is divided into strips with movable fences to control grazing access. See also **rotational grazing**.

surface runoff: The rate at which water disappears from the soil surface by absorption or flowing over the soil.

T

terminal bud: The point where the new season's growth starts; it is usually larger than a lateral bud and is found at the stem tip.

terminal bud scar: A mark found where the previous year's terminal bud was located.

trifoliate: Having three leaflets, either palmate or pinnate.

V

vegetative: Leafy.

venation: The arrangement of veins in a leaf.

W

warm-season grass: Grass that grows best during the summer when temperatures fall between 77 and 104 degrees Fahrenheit.

whorled: Leaf arrangement in which three or more leaves or buds are arranged in a circle at one point on the stem.

woody plant: A plant with a tough, woody (nonherbaceous) stem, may be a shrub, vine, or tree.

Crop and Grassland Plant Identification Manual

In cooperation with
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Arts and Vocational-Technical Education
College of Education and College of Agriculture,
Food and Natural Resources
University of Missouri - Columbia

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Agricultural Education Section
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CROP AND GRASSLAND PLANT IDENTIFICATION MANUAL

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FOREWORD

The development of the *Crop and Grassland Plant Identification Manual* is the result of suggestions by the MVATA Teaching Aids Committee. The Grassland Management Advisory Committee suggested the material to be included and reviewed the materials.

This manual can be used with the *Introduction to Grassland Management* and *Crop Science* curriculums available from IML. It may also be used independently as a general reference for identification of common species of grasses, legumes, forbs, and woody plants.

During the summer of 1981, the Missouri State Board of Education formally adopted the concept of "Instructional Management Systems" (IMS) as a priority for the 1981-82 school year. The Missouri Commissioner of Education described the IMS concept as a practical way of "organizing for excellence" in education. To meet the demand for greater productivity and accountability, the director of Vocational Education applied the elements of IMS to form the Vocational Instructional Management System (VIMS). The VIMS process provides a framework to use in planning and organizing to assure excellence in Missouri's vocational education system by focusing greater attention on the management of teaching and learning.

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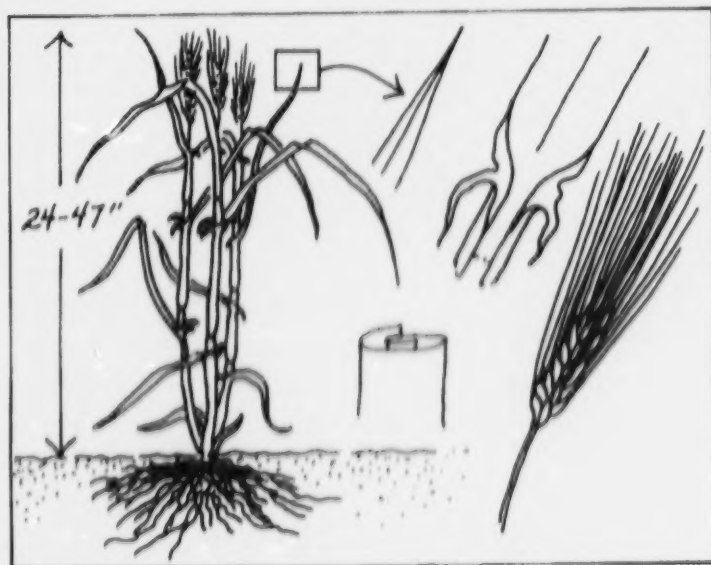
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Grasses and Grasslike Plants

Barley - *Hordeum vulgare*
Barnyardgrass - *Echinochloa crusgalli*
Bermudagrass - *Cynodon dactylon*
Big bluestem - *Andropogon gerardi*
Bromegrass - *Bromus inermis*
Broomsedge - *Andropogon virginicus*
Canada bluegrass - *Poa compressa*
Caucasian bluestem - *Andropogon caucasicus*
Cheat/Chess - *Bromus secalinus*
Corn - *Zea mays*
Crabgrass - *Digitaria sanguinalis*
Downy chess - *Bromus tectorum*
Fall panicum - *Panicum dichotomiflorum*
Giant foxtail - *Setaria faberi*
Goosegrass - *Eleusine indica*
Green foxtail - *Setaria viridis*
Indiangrass - *Sorghastrum nutans*
Johnsongrass - *Sorghum halepense*
Kentucky bluegrass - *Poa pratensis*
Little bluestem - *Andropogon scoparius*
Oats - *Avena sativa*
Orchardgrass - *Dactylis glomerata*
Perennial ryegrass - *Lolium perenne*
Prairie cupgrass - *Eriochloa contracta*
Purpletop - *Tridens flavus*
Quackgrass - *Agropyron repens*
Redtop - *Agrostis alba*
Reed canarygrass - *Phalaris arundinacea*
Rice - *Oryza sativa*
Rye - *Secale cereale*
Sandbur - *Cenchrus longispinus*
Smooth crabgrass - *Digitaria ischaemum*
Switchgrass - *Panicum virgatum*
Tall fescue - *Festuca arundinacea*
Three-awn grass - *Aristida oligantha*
Timothy - *Phleum pratense*
Wheat - *Triticum aestivum*
Wirestem muhly - *Muhlenbergia frondosa*
Witchgrass - *Panicum capillare*
Yellow foxtail - *Setaria glauca*
Yellow nutgrass or chufa - *Cyperus esculentus*

Grass and Grasslike Plant Identification						
Common Name Botanical Name	Grass Type	Life Cycle	Natural Height	Growth Habit	Texture	Bud Leaf Arrangement
Barley <i>Hordeum vulgare</i>	cool-season grass	annual	24-47"	bunch	coarse	rolled
Barnyardgrass <i>Echinochloa crusgalli</i>	warm-season grass	annual	12-39"	fibrous	coarse	folded
Bermudagrass <i>Cynodon dactylon</i>	warm-season grass	perennial	12"	rhizomes and stolons	fine	folded
Big bluestem <i>Andropogon gerardi</i>	warm-season grass	perennial	3-8'	rhizomes	coarse	rolled



Barley
Hordeum vulgare



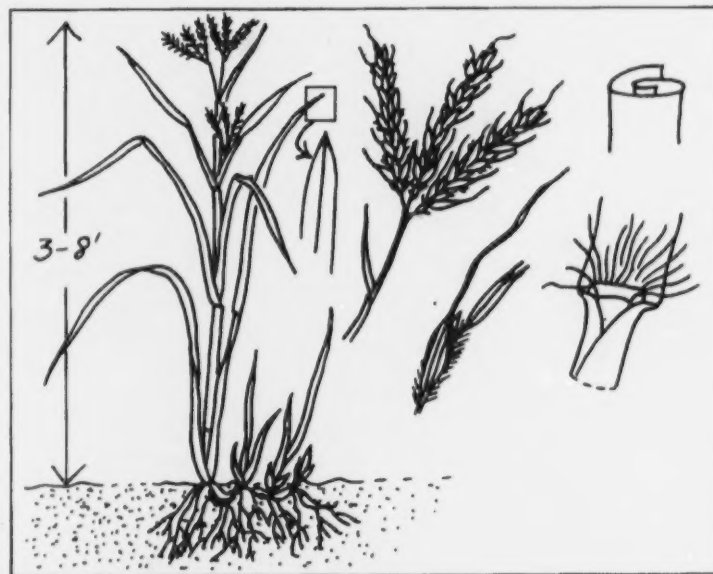
Barnyardgrass
Echinochloa crusgalli

Grasses and Grasslike Plant Identification

Sheath	Auricle	Collar	Ligule	Blade	Blade Tip	Inflorescence
split, overlapping	absent	smooth, narrow	absent	boat-shaped underneath, smooth surfaces with rough margins	tapering to tip	panicle
slightly flat with tufts of hair at base of plant; rounded, smooth, overlapping on upper plant	absent	narrow with hairs on the edge	absent	flat or folded, usually smooth, some hairs	sharply tapering to tip	panicle
compressed, split with overlapping margins	absent	hairy on margins	membranous	flat or v-shaped, lower blades covered with silky hairs	tapering to tip	raceme with digitate spikelets
short, flattened at the base, hairs on lower margin	absent	-----	fringe of hairs, truncated	flat or folded, prominent midrib, long scattered hairs at base on upper side	tapering to tip	enclosed in the sheath, raceme appearance

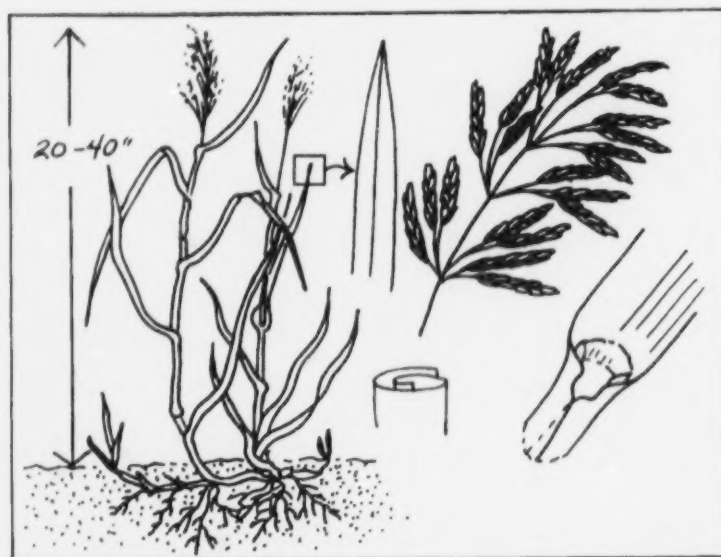


Bermudagrass
Cynodon dactylon

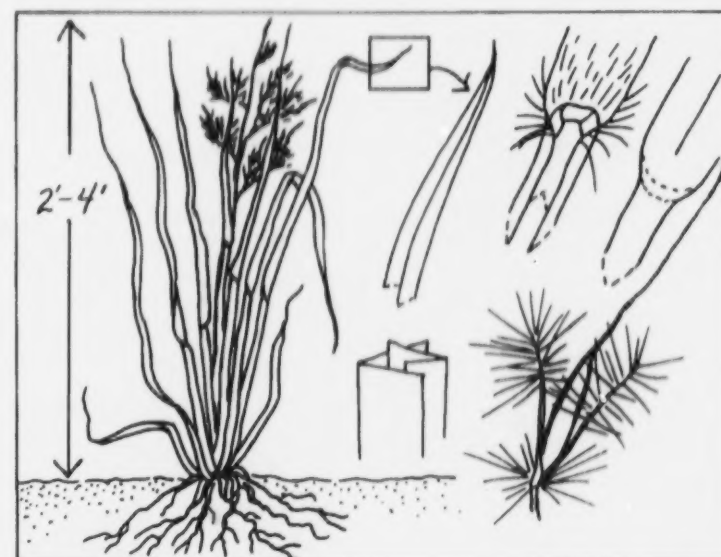


Big bluestem
Andropogon gerardi

Grass and Grasslike Plant Identification						
Common Name Botanical Name	Grass Type	Life Cycle	Natural Height	Growth Habit	Texture	Bud Leaf Arrangement
Bromegrass <i>Bromus inermis</i>	cool-season grass	perennial	20-40"	rhizomes	coarse	rolled
Broomsedge <i>Andropogon virginicus</i>	warm-season grass	perennial	2-4'	bunch	coarse	folded
Canada bluegrass <i>Poa compressa</i>	cool-season grass	perennial	6-20"	rhizomes	medium	folded
Caucasian bluestem <i>Andropogon caucasicus</i>	warm-season grass	perennial	2-4'	bunch	medium to coarse	rolled

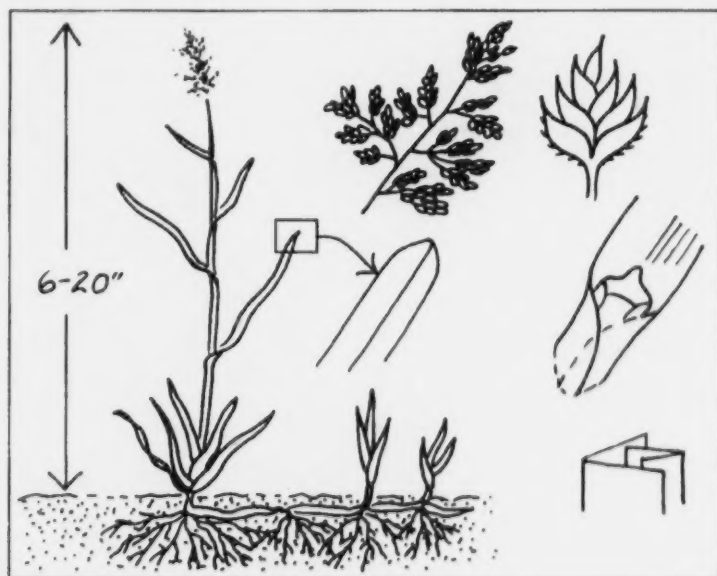


Bromegrass
Bromus inermis

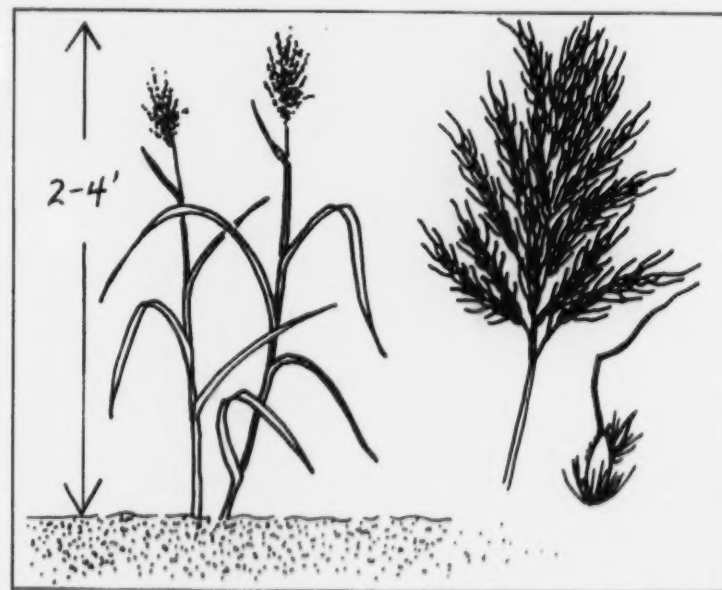


Broomsedge
Andropogon virginicus

Grasses and Grasslike Plant Identification						
Sheath	Auricle	Collar	Ligule	Blade	Blade Tip	Inflorescence
smooth, split margins, overlapping	absent	----	membranous	smooth, blue or purple hue	tapering to tip	raceme digitate spikelets
smooth, compressed, split	absent	narrow, smooth	short to medium, blunt	flat to v-shaped, smooth	boat-shaped	raceme
smooth or sometimes soft hairs, split with overlapping margins	absent	----	rough margin	flat, slightly hairy to smooth	parallel-sided	panicle
split	absent	----	hairy	v-shaped, narrow, hairy	tapering to tip	narrow panicle



Canada bluegrass
Poa compressa

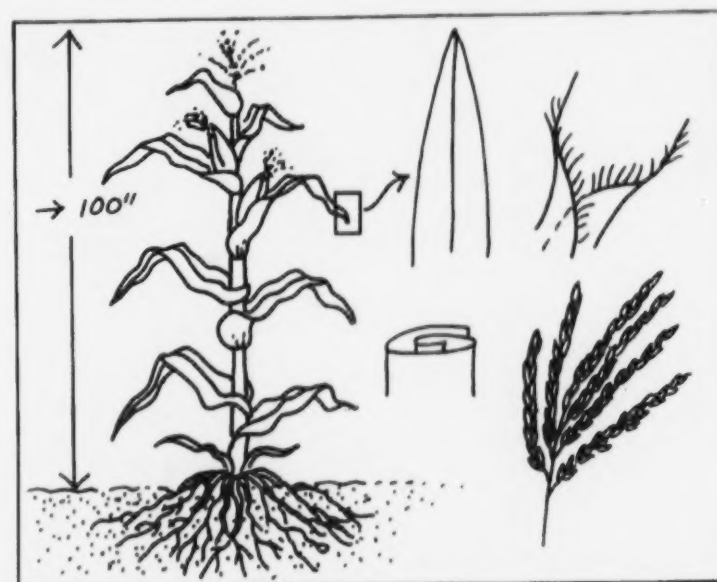


Caucasian bluestem
Andropogon caucasicus

Grass and Grasslike Plant Identification						
Common Name Botanical Name	Grass Type	Life Cycle	Natural Height	Growth Habit	Texture	Bud Leaf Arrangement
Cheat/Chess <i>Bromus secalinus</i>	cool-season grass	annual	12-24"	bunch	medium	rolled
Corn <i>Zea mays</i>	warm-season grass	annual	up to 100"	adventitious root system from nodes	medium	rolled
Crabgrass <i>Digitaria sanguinalis</i>	warm-season grass	annual	15-24"	fibrous with stolons	coarse	rolled
Downy chess <i>Bromus tectorum</i>	cool-season grass	annual	12-24"	bunch	coarse	rolled

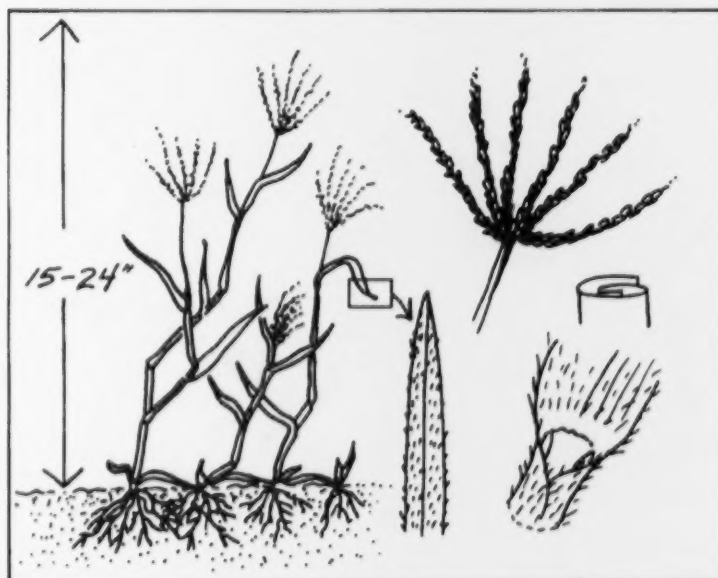


Cheat/Chess
Bromus secalinus



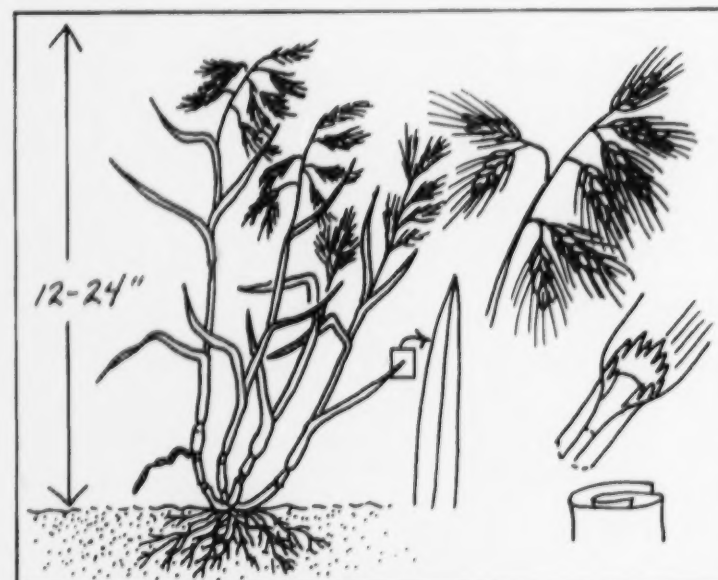
Corn
Zea mays

Grasses and Grasslike Plant Identification						
Sheath	Auricle	Collar	Ligule	Blade	Blade Tip	Inflorescence
split with overlapping margins	absent	-----	membranous, toothed	broad, smooth	tapering to tip	long spikelike raceme
hairy, split with overlapping margins	absent	-----	membranous	short, broad, hairy, purple hue	tapering to tip	raceme with digitate spikelets
covered with short soft hairs, round, closed	small	-----	membranous, toothed, acute	flat, covered with short silky hairs on both surfaces	tapering to tip	panicle with dense, soft, purplish spikelets
smooth, split	absent	-----	membranous, jagged, dense fringe of white hairs	flat, covered with short stiff hairs, white midrib	finely pointed	panicle



Crabgrass
Digitaria sanguinalis

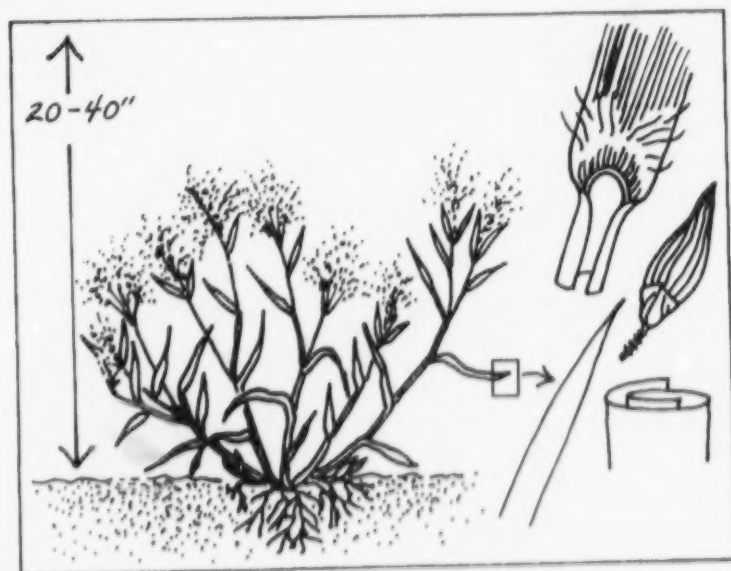
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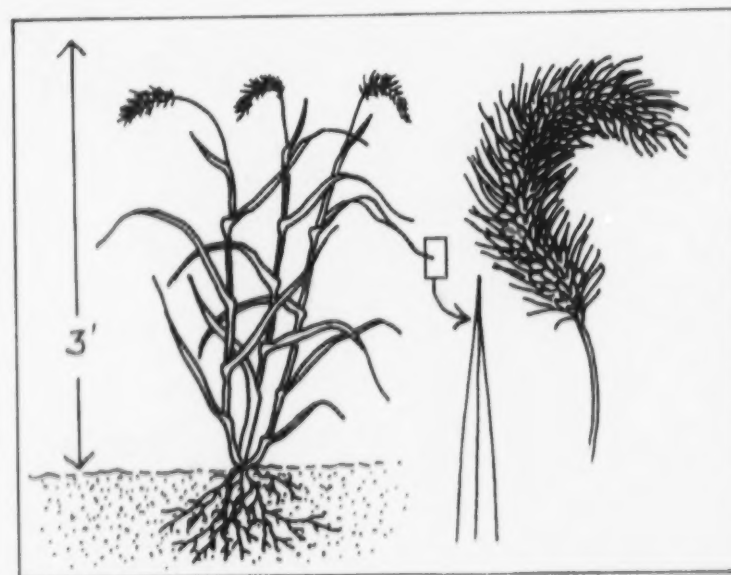
Downy chess
Bromus tectorum

243

Grass and Grasslike Plant Identification						
Common Name Botanical Name	Grass Type	Life Cycle	Natural Height	Growth Habit	Texture	Bud Leaf Arrangement
Fall panicum <i>Panicum dichotomiflorum</i>	warm-season grass	annual	20-40"	fibrous	coarse	rolled
Giant foxtail <i>Setaria faberi</i>	warm-season grass	annual	3'	fibrous	coarse	rolled
Goosegrass <i>Eleusine indica</i>	warm-season grass	annual	4-30"	bunch	coarse	rolled
Green foxtail <i>Setaria viridis</i>	warm-season grass	annual	12-40"	bunch	medium to coarse	rolled

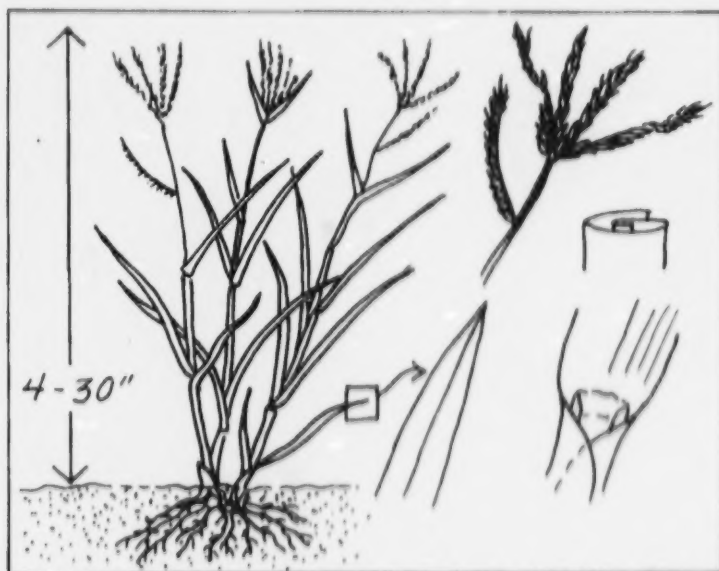


Fall panicum
Panicum dichotomiflorum

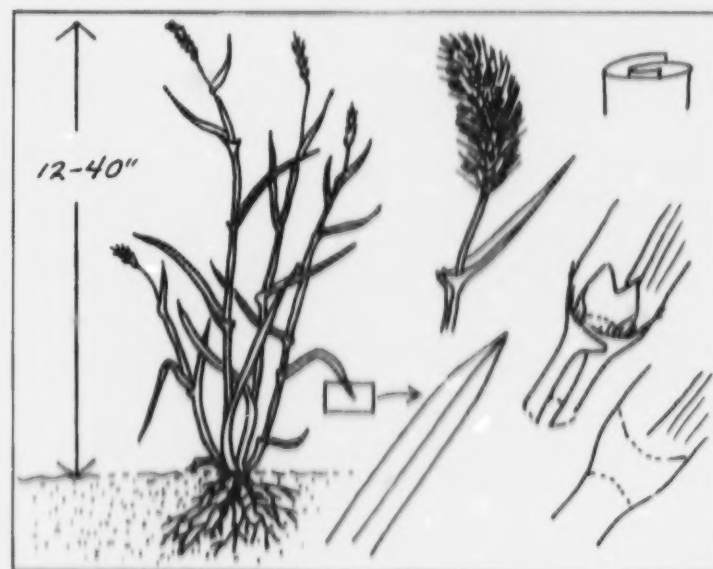


Giant foxtail
Setaria faberi

Grasses and Grasslike Plant Identification						
Sheath	Auricle	Collar	Ligule	Blade	Blade Tip	inflorescence
compressed, smooth	absent	*****	membranous, fringed with hairs	sharply ridged, hairy upper surface	tapering to tip	panicle, spike-like
smooth, split with overlapping margins	absent	*****	blunt, small, membranous, may have fringe of hairs	short, broad, smooth, prominent veins	rounded to blunt	raceme with digitate spikelets
rounded, split, margins hairy and overlapping	absent	*****	short and membranous with fringe of hairs	smooth, erect	tapering to tip	spike
closed, may have slightly hairy margin	large, brown, horn-like	smooth, broad, yellow	short membrane with fringe of hairs	flat or boat-shaped, no hairs	tapering to tip	golden panicle



Goosegrass
Eleusine indica

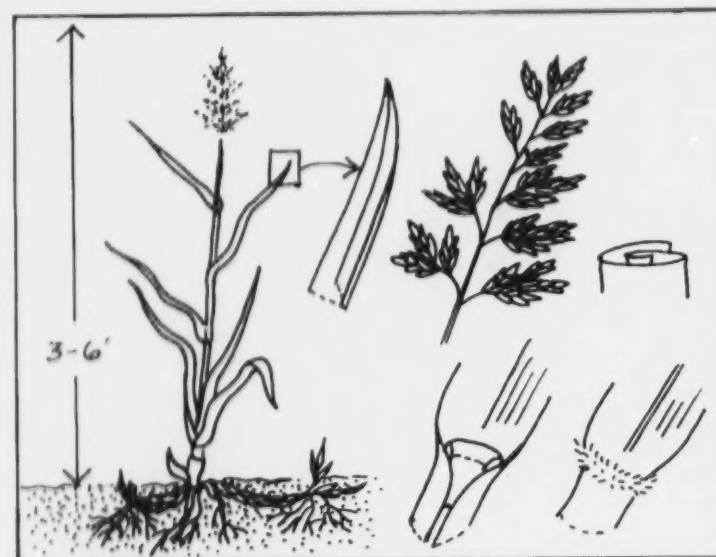


Green foxtail
Setaria viridis

Grass and Grasslike Plant Identification						
Common Name Botanical Name	Grass Type	Life Cycle	Natural Height	Growth Habit	Texture	Bud Leaf Arrangement
Indiangrass <i>Sorghastrum nutans</i>	warm-season grass	perennial	4-8'	rhizomes	coarse	rolled
Johnsongrass <i>Sorghum halepense</i>	warm-season grass	perennial	3-6'	thick rhizomes	coarse	rolled
Kentucky bluegrass <i>Poa pratensis</i>	cool-season grass	perennial	12-24"	rhizomes and tillers	medium	folded
Little bluestem <i>Andropogon scoparius</i>	warm-season grass	perennial	2-5'	bunch	medium to coarse	folded



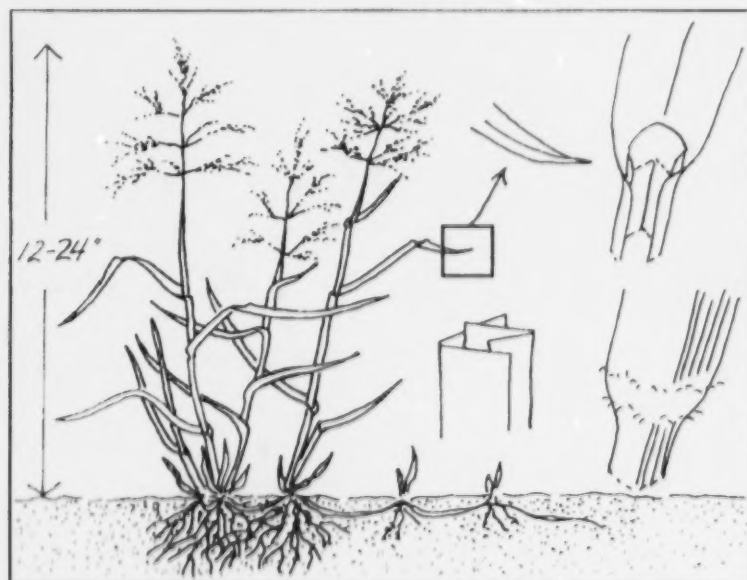
Indiangrass
Sorghastrum nutans



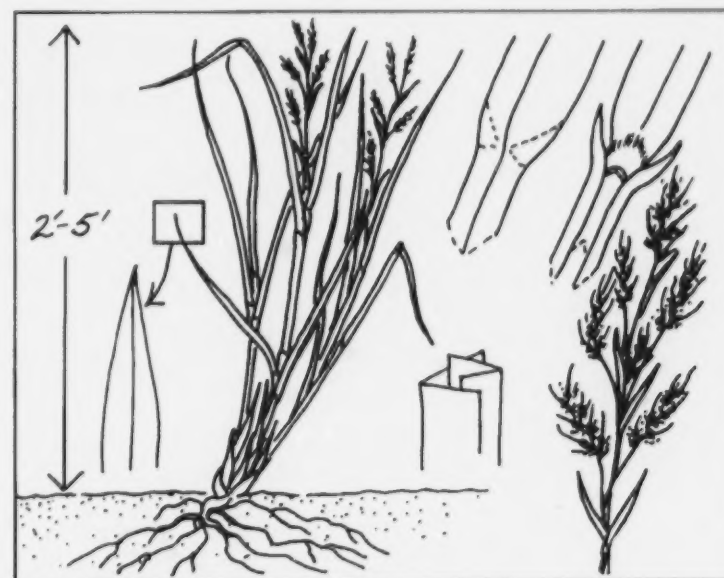
Johnsongrass
Sorghum halepense

Grasses and Grasslike Plant Identification

Sheath	Auricle	Collar	Ligule	Blade	Blade Tip	Inflorescence
split, rounded	small to absent	----	hairy fringe	thick, flat, light-colored midrib, smooth	tapering to tip	panicle, green with purple hue
open, smooth except for a few hairs on the margin of some plants	absent	medium with slight hairs	long, prominent membrane with fringe of hairs	v-shaped, boat-shaped, smooth	boat-shaped and smooth	panicle
smooth, split	large, well developed	-----	small-toothed, truncated	flat, stiff, rough upper surface	tapering to tip	spike
split, keeled	large, hornlike	divided	hairy, membranous	folded; flat, bluish basal shoots	tapering to tip	raceme



Kentucky bluegrass
Poa pratensis

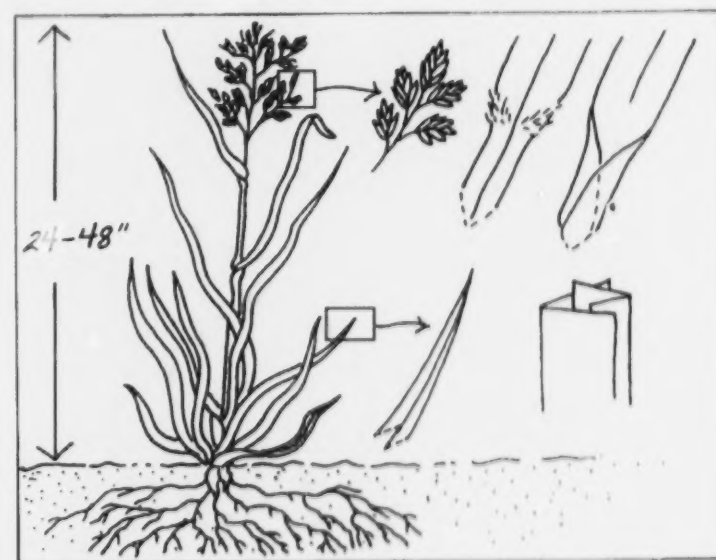


Little bluestem
Andropogon scoparius

Grass and Grasslike Plant Identification						
Common Name Botanical Name	Grass Type	Life Cycle	Natural Height	Growth Habit	Texture	Bud Leaf Arrangement
Oats <i>Avena sativa</i>	cool-season grass	annual	24-32"	bunch	medium	rolled
Orchardgrass <i>Dactylis glomerata</i>	cool-season grass	perennial	24-48"	bunch	coarse	folded
Perennial ryegrass <i>Lolium perenne</i>	cool-season grass	perennial	20"	bunch	medium to coarse	folded
Prairie cupgrass <i>Eriochloa contracta</i>	warm-season grass	annual	6-32"	bunch	coarse	rolled

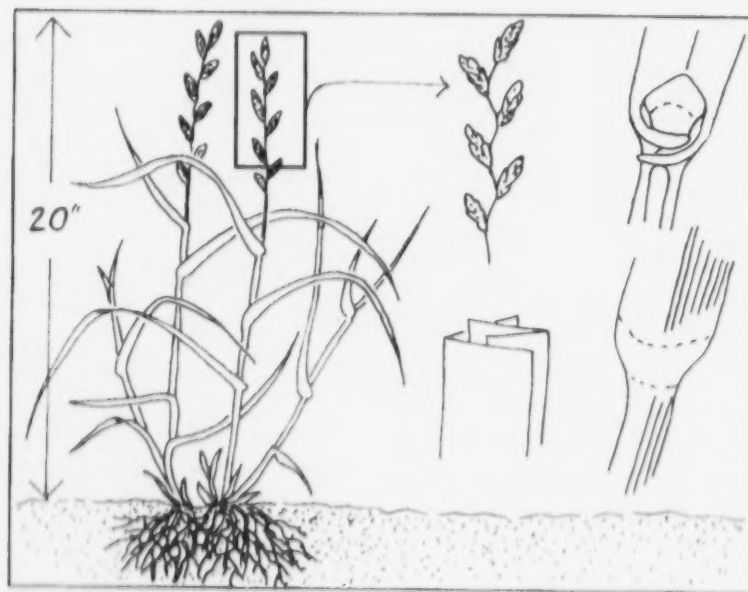


Oats
Avena sativa

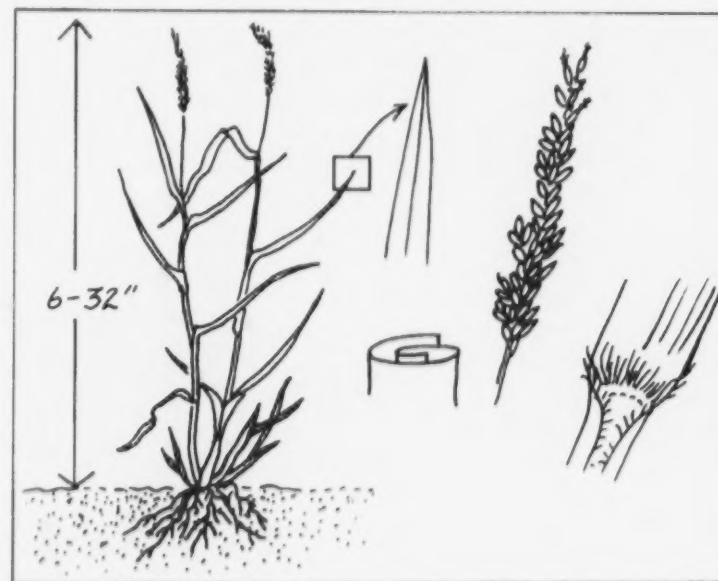


Orchardgrass
Dactylis glomerata

Grasses and Grasslike Plant Identification						
Sheath	Auricle	Collar	Ligule	Blade	Blade Tip	Inflorescence
split	absent	-----	membranous	flat, wide	tapering to tip	panicle
closed with overlapping margins, compressed, boat-shaped	absent	divided with few hairs, light green	pointed, jagged, smooth membrane	v-shaped, rough margins and midribs	boat-shaped	panicle
open, flat, smooth, reddish base	small, claw-like	broad and distinct	small, blunt to pointed	flat, boat-shaped underneath, glossy on bottom	tapering to tip, pointed	spike
split, short hairs	absent	-----	dense fringe of hairs, membranous	flat, short hairs	tapering to tip, pointed	narrow panicle

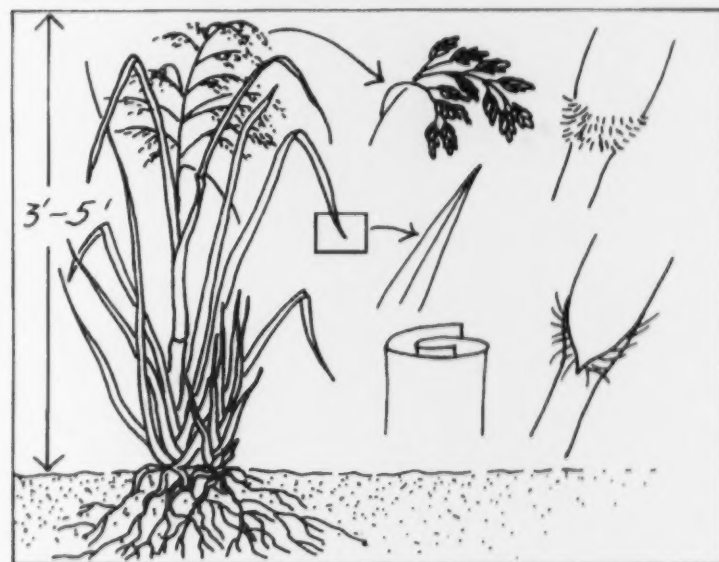


Perennial ryegrass
Lolium perenne

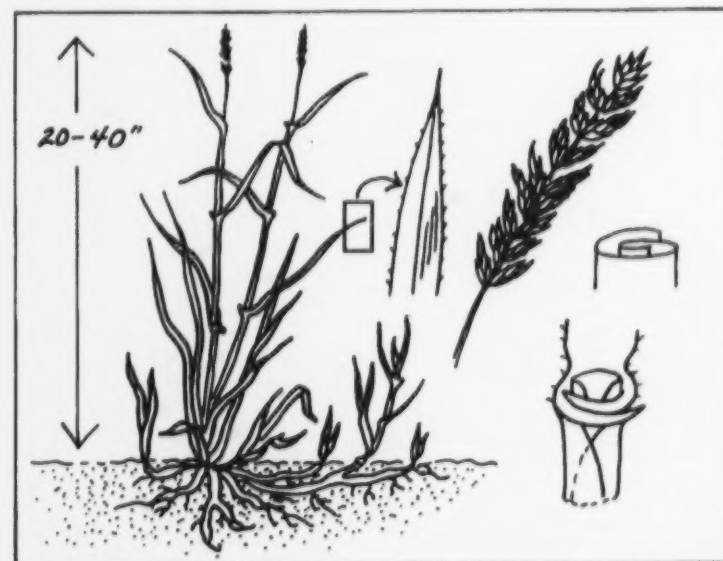


Prairie cupgrass
Eriochloa contracta

Grass and Grasslike Plant Identification						
Common Name Botanical Name	Grass Type	Life Cycle	Natural Height	Growth Habit	Texture	Bud Leaf Arrangement
Purpletop <i>Tridens flavus</i>	warm-season grass	perennial	3-5'	bunch, some rhizomes	medium to coarse	rolled
Quackgrass <i>Agropyron repens</i>	cool-season grass	perennial	20-40"	rhizomes	medium to coarse	rolled
Redtop <i>Agrostis alba</i>	cool-season grass	perennial	40-60"	rhizomes	coarse	rolled
Reed canarygrass <i>Phalaris arundinacea</i>	cool-season grass	perennial	24-72"	rhizomes	coarse	rolled

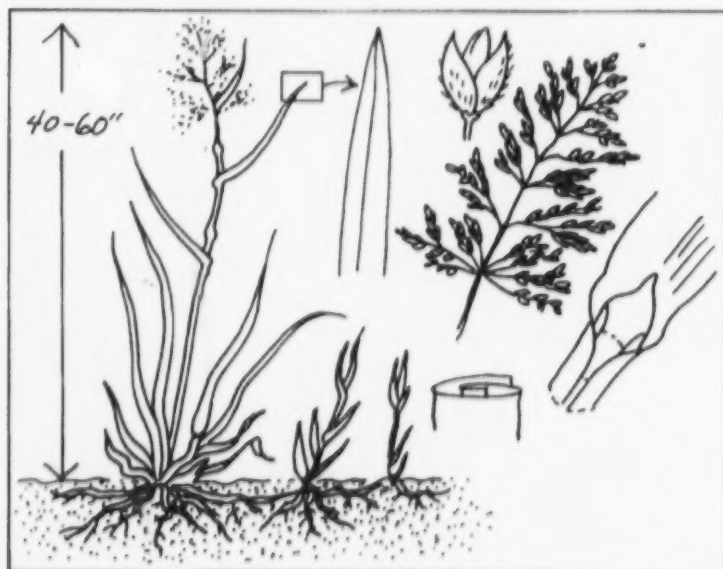


Purpletop
Tridens flavus

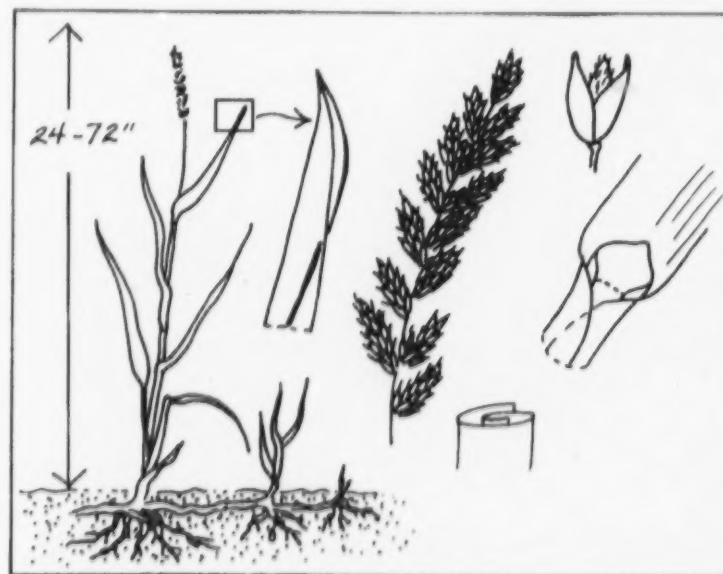


Quackgrass
Agropyron repens

Grasses and Grasslike Plant Identification						
Sheath	Auricle	Collar	Ligule	Blade	Blade Tip	Inflorescence
closed with hairy margin	absent	hairy	fringe of hairs from small membrane	wide, flat, prominent midrib at base	tapering to narrow tip	purple panicle
smooth, split with overlapping margins	large, clawlike	*****	small, blunt membrane	thin, flat, hairy margin, sparsely hairy on upper surface	tapering to tip	spike
round, smooth, split	absent	distinct, smooth	long, usually pointed	flat, ribbed, rough margins	tapering to tip	reddish panicle
smooth, split with overlapping margins	absent	*****	large, acute	flat with rough margins	boat-shaped	narrow panicle

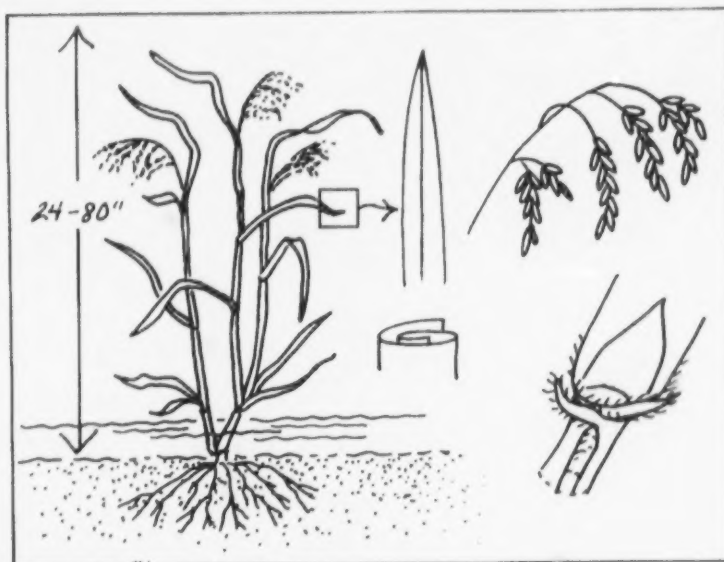


Redtop
Agrostis alba



Reed canarygrass
Phalaris arundinacea

Grass and Grasslike Plant Identification						
Common Name Botanical Name	Grass Type	Life Cycle	Natural Height	Growth Habit	Texture	Bud Leaf Arrangement
Rice <i>Oryza sativa</i>	warm-season grass	annual	24-80"	fibrous	coarse	rolled
Rye <i>Secale cereale</i>	cool-season grass	annual	5-6'	bunch	coarse	rolled
Sandbur <i>Cenchrus longispinus</i>	warm-season grass	annual	low, ground-covering main stems, 10-30" long	bunch	coarse	rolled
Smooth crabgrass <i>Digitaria ischaemum</i>	warm-season grass	annual	12-16"	stolons	medium	rolled



Rice
Oryza sativa

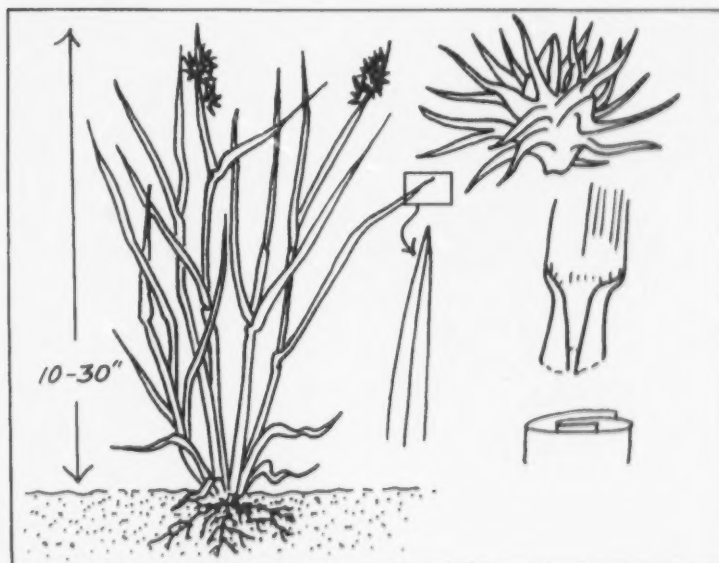


Rye
Secale cereale

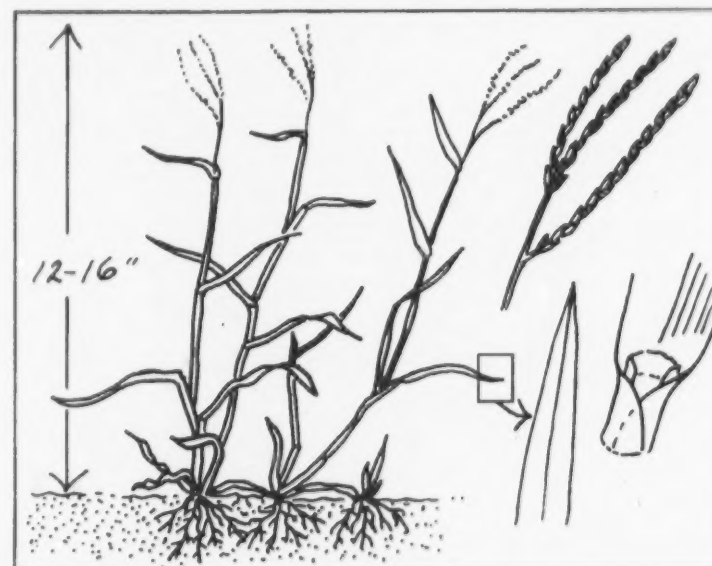
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Grasses and Grasslike Plant Identification

Sheath	Auricle	Collar	Ligule	Blade	Blade Tip	Inflorescence
split with hairs	large and clawlike with hairs	-----	very large, pointed membrane	flat, narrow, long, ribbed	tapering to tip	1-flowered panicle
split	claw-like	-----	membranous, blunt	flat	tapering to tip	2-flowered spike
flattened, split, sparse hairs on margin	absent	-----	short fringe of hairs	flat, boat-shaped at the base	tapering to tip	burs in spike-formed raceme
round, smooth, closed	small, if present	medium, divided	short, blunt	flat, long, smooth, "W" or "M" on blades	tapering to tip	panicle

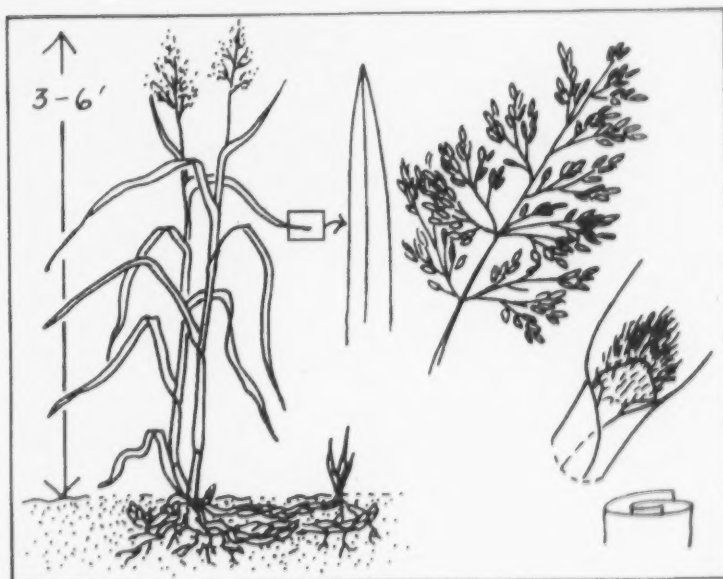


Sandbur
Cenchrus longispinus

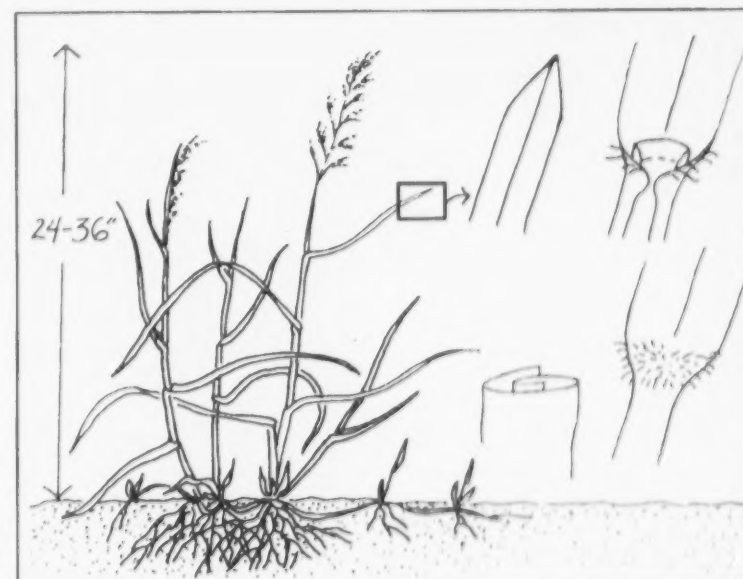


Smooth crabgrass
Digitaria ischaemum

Grass and Grasslike Plant Identification						
Common Name Botanical Name	Grass Type	Life Cycle	Natural Height	Growth Habit	Texture	Bud Leaf Arrangement
Switchgrass <i>Panicum virgatum</i>	warm-season grass	perennial	3-6'	rhizomes	coarse	rolled
Tall fescue <i>Festuca arundinacea</i>	cool-season grass	perennial	24-36"	bunch, few short rhizomes	medium to coarse	rolled
Three-awn grass <i>Aristida oligantha</i>	warm-season grass	annual	12-24"	bunch	medium	rolled
Timothy <i>Phleum pratense</i>	cool-season grass	perennial	20-40"	bunch	medium to coarse	rolled

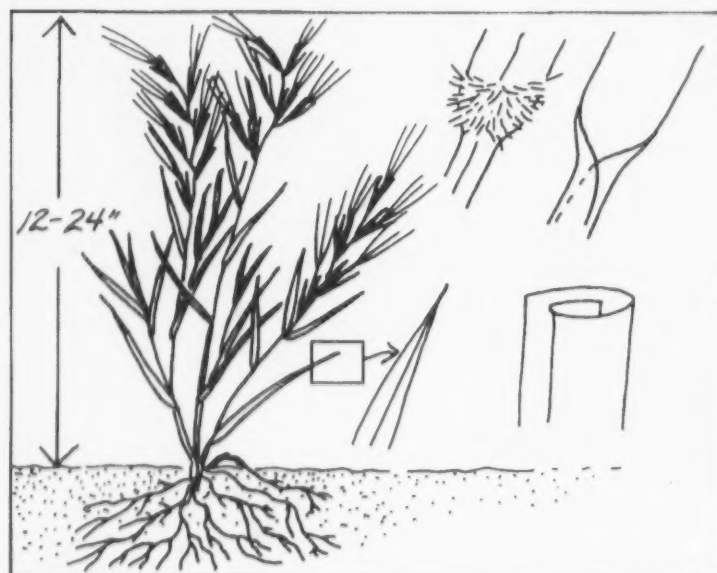


Switchgrass
Panicum virgatum

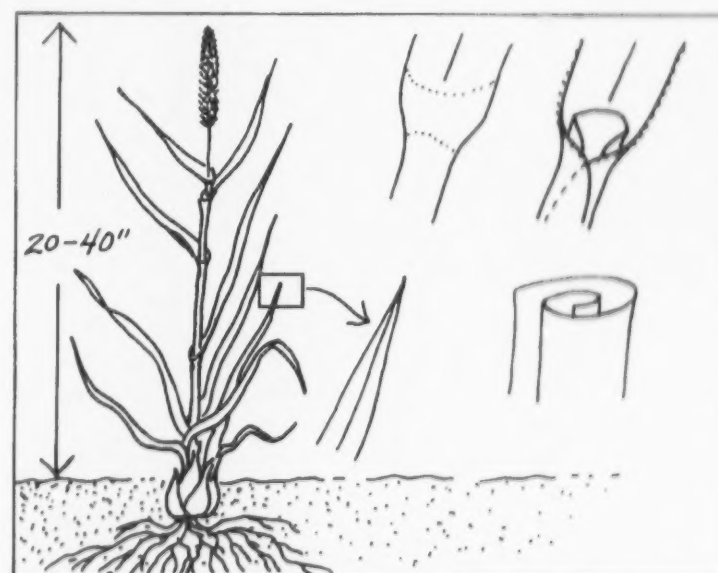


Tall fescue
Festuca arundinacea

Grasses and Grasslike Plant Identification						
Sheath	Auricle	Collar	Ligule	Blade	Blade Tip	Inflorescence
round, split with overlapping margins	absent	-----	very hairy, pointed	wide, dense, tuft of hair at point of attachment to sheath	tapering to tip	panicle
round, smooth, split	absent to blunt with hairs on margin	hairy, broad	indistinct, blunt	flat, wide edges, smooth underneath with ribbed, rough upper surface	tapered	raceme
rounded on back, split with overlapping margins	absent	hairy	short fringe of hairs	smooth, branches from base and lower nodes	tapering to fine point	raceme, three awns attached to each seed
round, split with overlapping or open margins, smooth	absent	distinct, broad, smooth	acute, toothed	wide, twisted, ribbed, rough margin	sharp, pointed	dense spike-like panicle



Three-awn grass
Aristida oligantha

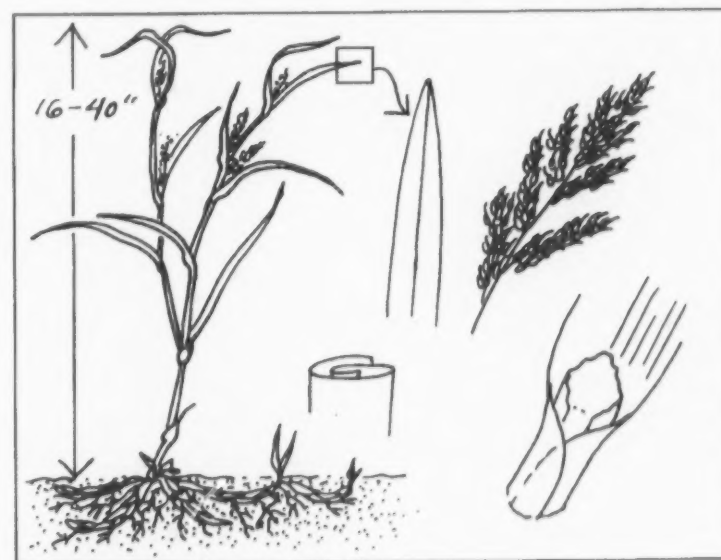


Timothy
Phleum pratense

Grass and Grasslike Plant Identification						
Common Name Botanical Name	Grass Type	Life Cycle	Natural Height	Growth Habit	Texture	Bud Leaf Arrangement
Wheat <i>Triticum aestivum</i>	cool-season grass	annual	24-40"	bunch	coarse	rolled
Wirestem muhly <i>Muhlenbergia frondosa</i>	warm-season grass	perennial	16-40"	rhizomes	coarse	rolled
Witchgrass <i>Panicum capillare</i>	warm-season grass	annual	8-30"	bunch	coarse	rolled
Yellow foxtail <i>Setaria glauca</i>	warm-season grass	annual	16-40"	bunch	medium to coarse	rolled

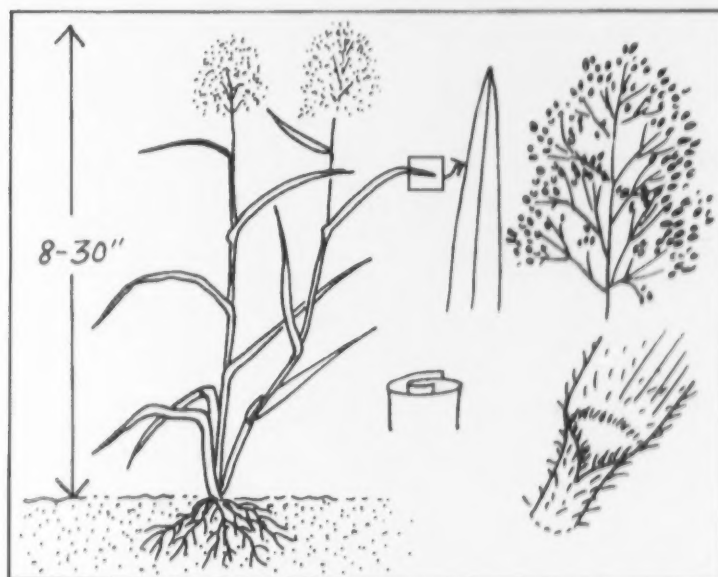


Wheat
Triticum aestivum



Wirestem muhly
Muhlenbergia frondosa

Grasses and Grasslike Plant Identification						
Sheath	Auricle	Collar	Ligule	Blade	Blade Tip	Inflorescence
split	clawlike	-----	membranous, blunt	flat	tapering to fine point	spike-like raceme
smooth	absent	-----	membranous	flat, rough	tapering to tip	tight panicle partly enclosed in leaf sheath
hairy, closed	absent	-----	short membrane with fringe of hairs	wide, densely hairy	tapering to tip	wide, spreading panicle
closed, smooth except for hairs along the margin	absent	-----	membrane fringed with hairs	v-shaped shiny, smooth	tapering to tip	umbel-like spikes, yellowish color to seed head

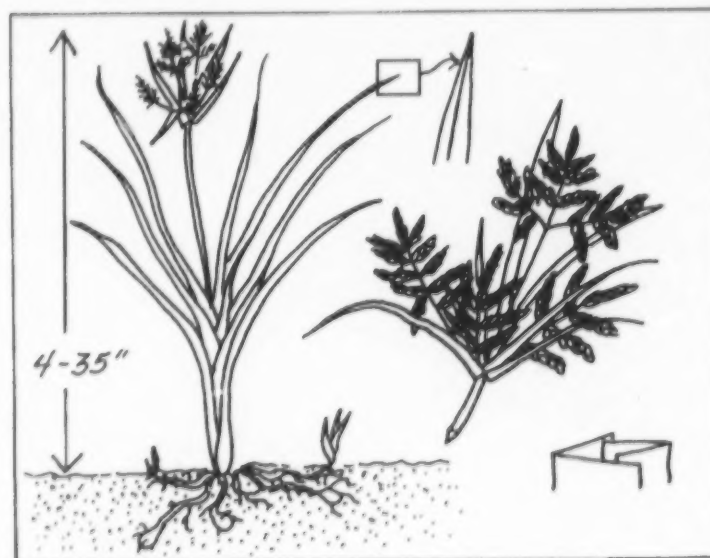


Witchgrass
Panicum capillare



Yellow foxtail
Setaria glauca

Grass and Grasslike Plant Identification						
Common Name Botanical Name	Grass Type	Life Cycle	Natural Height	Growth Habit	Texture	Bud Leaf Arrangement
Yellow nutgrass or chufa <i>Cyperus esculentus</i>	grasslike plant	perennial	4-35"	rhizomes	medium	folded



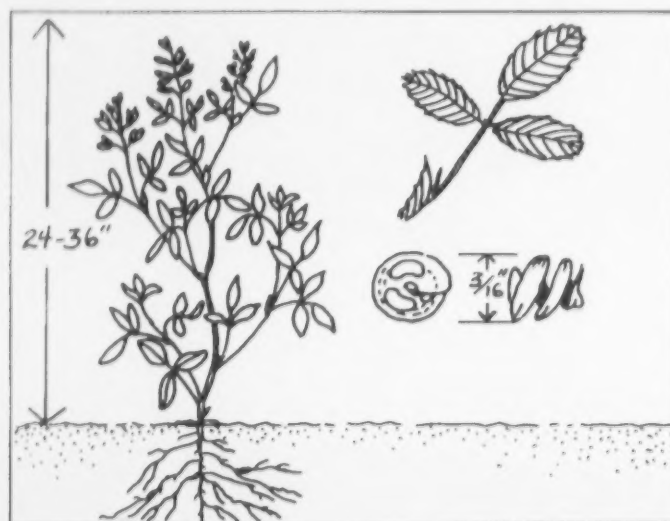
Yellow nutgrass or chufa
Cyperus esculentus

Grasses and Grasslike Plant Identification						
Sheath	Auricle	Collar	Ligule	Blade	Blade Tip	Inflorescence
smooth, flattened, split with overlapping margins	absent	may have long thin hairs	hairy, blunt, membranous	straight, smooth with waxy film	tapering to tip	spike

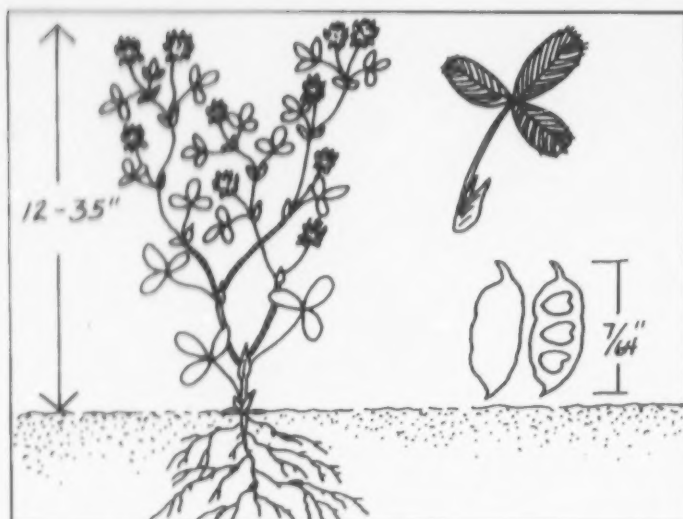
Legumes

- Alfalfa - *Medicago sativa*
- Alsike clover - *Trifolium hybridum*
- Birdsfoot trefoil - *Lotus corniculatus*
- Black medic - *Medicago lupulina*
- Common lespedeza or Japanese bush clover - *Kummerowia striata*
- Common vetch - *Vicia sativa*
- Crimson clover - *Trifolium incarnatum*
- Crown vetch - *Coronilla varia*
- Hairy vetch - *Vicia villosa*
- Illinois bundleflower - *Desmanthus illinoensis*
- Korean lespedeza - *Kummerowia stipulacea*
- Lead plant - *Amorpha canescens*
- Little hop clover - *Trifolium dubium*
- Low hop clover - *Trifolium campestre*
- Partridge pea - *Cassia fasciculata*
- Red clover - *Trifolium pratense*
- Sericea lespedeza or silky bush clover - *Lespedeza cuneata*
- Slender lespedeza - *Lespedeza virginica*
- Soybean - *Glycine max*
- Tick trefoil - *Desmodium spp.*
- White clover - *Trifolium repens*
- Yellow sweet clover - *Melilotus officinalis*

Legume Identification										
Common Name Botanical Name	Primary Use	Root Structure/ Modified Stems	Life Cycle	Plant Height	Petioles	Leaf Arrangement	Leaflet Shape	Leaflet Margin	Flower	Fruit
Alfalfa <i>Medicago sativa</i>	forage; food for quail, rabbits, deer	taproot with little branching	perennial	24-36"	stipules with serrated margins and pointed tip	pinnately trifoliate (3 leaflets)	obovate to oblanceolate	entire at base, upper 1/2 to 1/3 serrated	purple or blue raceme with 5 to 20 florets	several seeded, spiral-shaped (3 turns), 3/16" long, few hairs
Alsike clover <i>Trifolium hybridum</i>	forage; food for grouse, deer, prairie chickens, quail	taproot with little branching	perennial	12-35"	stipules at base, pointed tip	palmately trifoliate	orbicular	finely serrated	white to pink head with 17 to 91 florets	2 or 3 seeds, smooth, somewhat kidney-shaped, olive green to black, 7/64" long
Birdsfoot trefoil <i>Lotus corniculatus</i>	forage; food for deer and turkeys	taproot with a lot of lateral branching, rhizomes	perennial	24-36"	no stipules	pentifoliate (5 leaflets), 3 leaflets at tip of petiole and 2 at base	obovate	entire	bright yellow umbel with 4 to 7 florets	3 to 43 seeds, straight, mottled, dark brown, attached in the shape of a bird's foot, 1-1 1/2" long
Black medic <i>Medicago lupulina</i>	food for quail, deer, rabbits	taproot with lateral branching	annual	3-30"	stipules irregularly serrated	pinnately trifoliate	obovate	entire at base, upper 1/2 to 1/3 serrated	yellow head with 9 to 28 florets, 1/8"-1/4" in diameter	1 seed, inky black



Alfalfa
Medicago sativa



Alsike clover
Trifolium hybridum

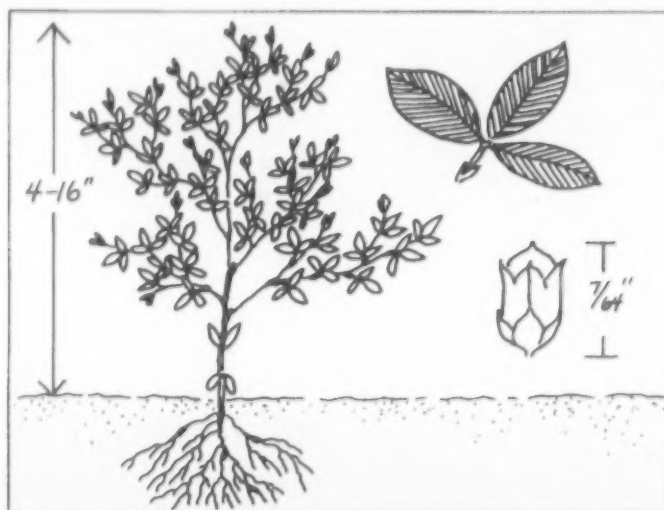


Birdsfoot trefoil
Lotus corniculatus

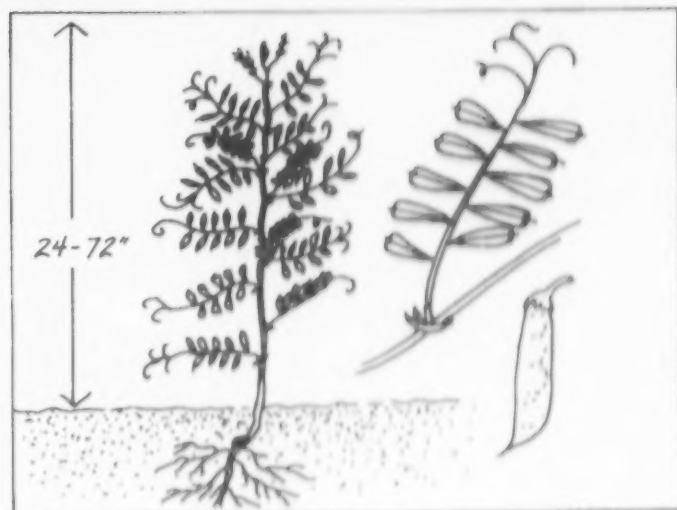


Black medic
Medicago lupulina

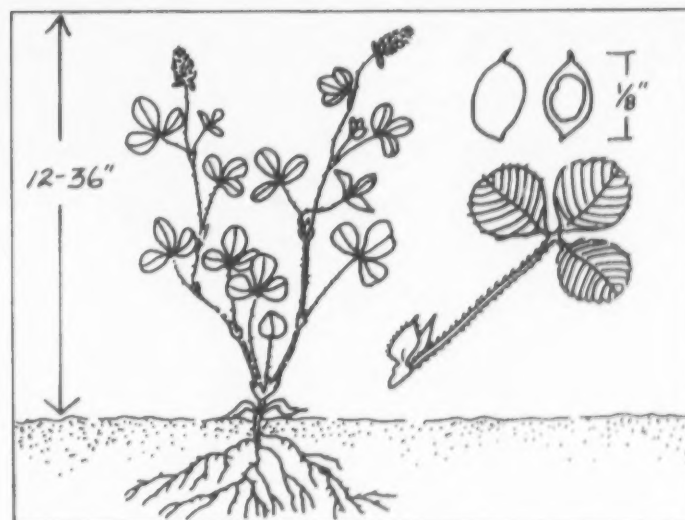
Legume Identification										
Common Name Botanical Name	Primary Use	Root Structure/ Modified Stems	Life Cycle	Plant Height	Petioles	Leaf Arrangement	Leaflet Shape	Leaflet Margin	Flower	Fruit
Common lespedeza or Japanese bush clover <i>Kummerowia striata</i>	forage; food for quail, deer, turkeys	taproot	annual	4-16"	small stipules, smooth petioles covered with short hairs	palmately trifoliate	obovate	entire	simple, pale purple-blue	tapering to terminal tip, 1/2 to 3/4 covered by calyx
Common vetch <i>Vicia sativa</i>	food for grouse, small mammals, turkeys	taproot	annual	24-72"	small stipules, purple at node	pinnate leaflets, terminal tendrils	obovate	entire	reddish purple raceme	4 to 12 pale brown to almost black seeds
Crimson clover <i>Trifolium incarnatum</i>	forage; food for grouse, quail, rabbits	taproot with a lot of lateral branching	annual	12-36"	very hairy, stipules also hairy, short and rounded, and sometimes reddish purple	palmately trifoliate	obovate	upper half dentate	crimson head with 65 to 125 florets	1 seed, ovoid, 1/8"
Crown vetch <i>Coronilla varia</i>	food for grouse, small mammals, turkeys	deep taproot and many rhizomes	perennial	12-20"	narrow, pointed stipules	pinnate with odd number of leaflets	oblong	entire	white to purple umbel	legume with 3 to 12 segments



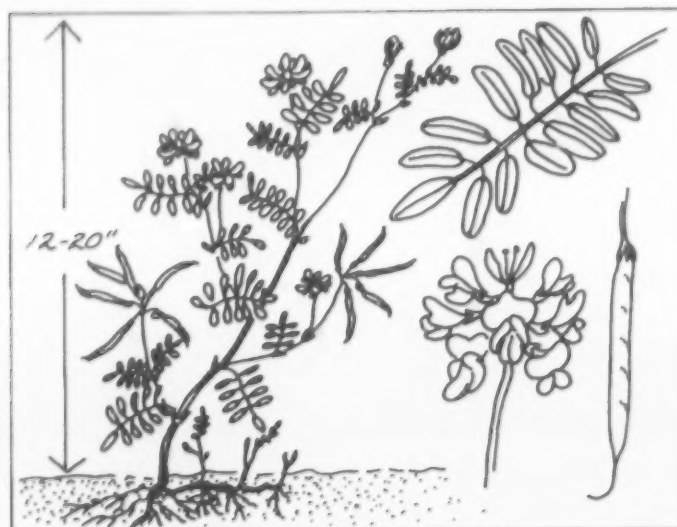
Common lespedeza or Japanese bush clover
Kummerowia striata



Common vetch
Vicia sativa

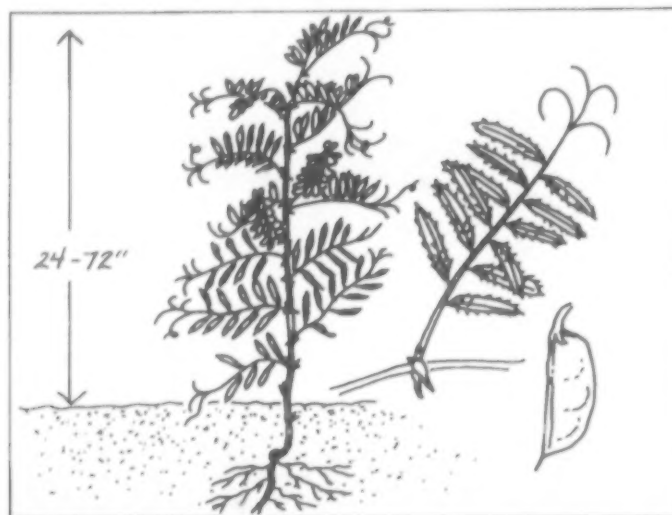


Crimson clover
Trifolium incarnatum

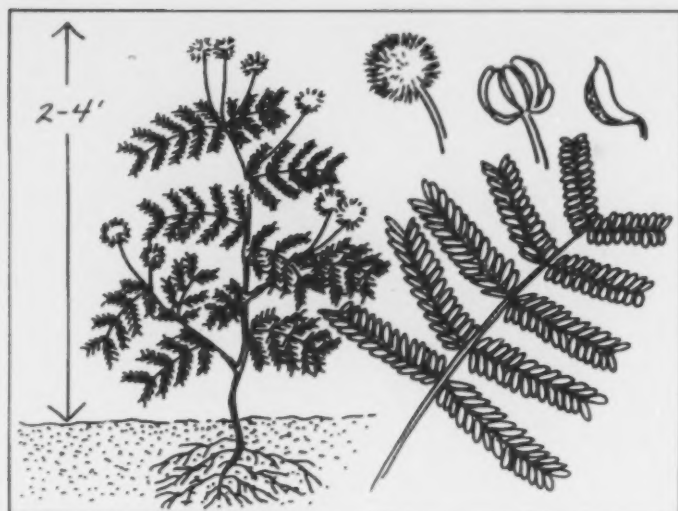


Crown vetch
Coronilla varia

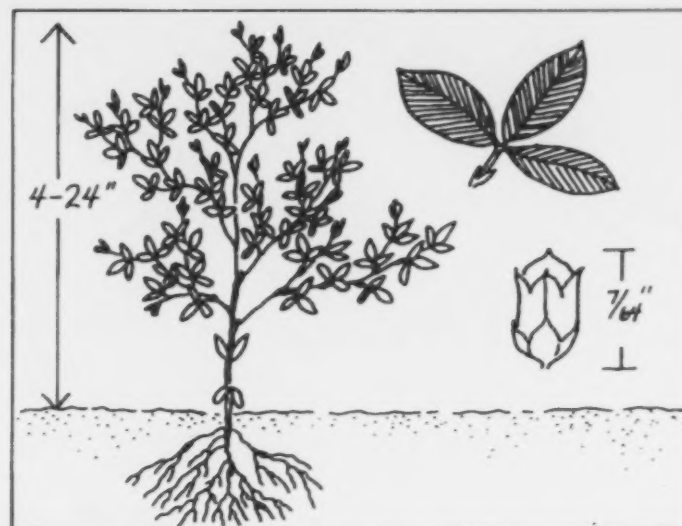
Legume Identification										
Common Name Botanical Name	Primary Use	Root Structure/ Modified Stems	Life Cycle	Plant Height	Petioles	Leaf Arrangement	Leaflet Shape	Leaflet Margin	Flower	Fruit
Hairy vetch <i>Vicia villosa</i>	forage; food for grouse, small mammals, turkeys	taproot	annual	24-72"	small, thin, pointed stipules	pinnate leaflet, terminal tendrils	oblong	entire, hairy	blue-violet raceme	smooth to few hairs, 1 to 1½" long
Illinois bundleflower <i>Desmanthus illinoensis</i>	food for quail, meadowlarks, turkeys	taproot	perennial	2-4'	very hairy stipules	bipinnate	oblong	entire	white head with 30 to 50 florets	clusters of 20 to 30 brown seed pods
Korean lespedeza <i>Kummerowia stipulacea</i>	forage; food for quail, deer, turkeys	taproot	annual	4-24"	large stipules, veins visible	palmately trifoliate, leaflets connected at base to form small cone shape	obovate	entire, hairy, leaf stems also hairy	simple, purple-blue	oval, half covered by calyx
Lead plant <i>Amorpha canescens</i>	food for quail, turkeys	taproot and rhizomes	perennial	12-32"	densely hairy, small stipules	pinnate with odd number of leaflets	obovate to oblong	entire	bright violet raceme cluster with 3 to 30 florets	small



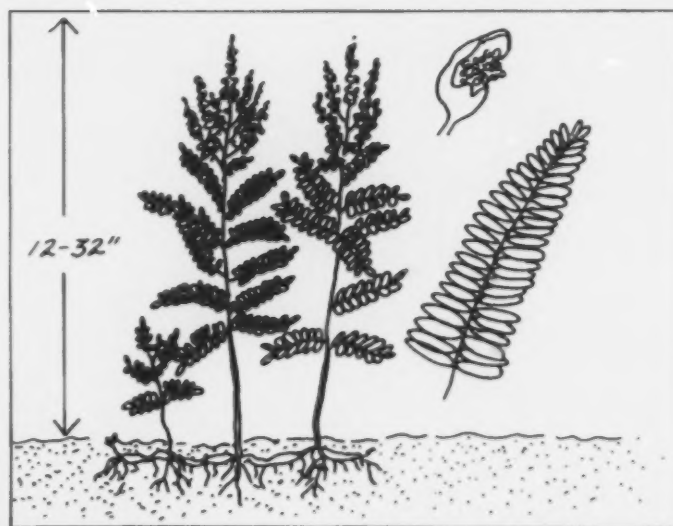
Hairy vetch
Vicia villosa



Illinois bundleflower
Desmanthus illinoensis

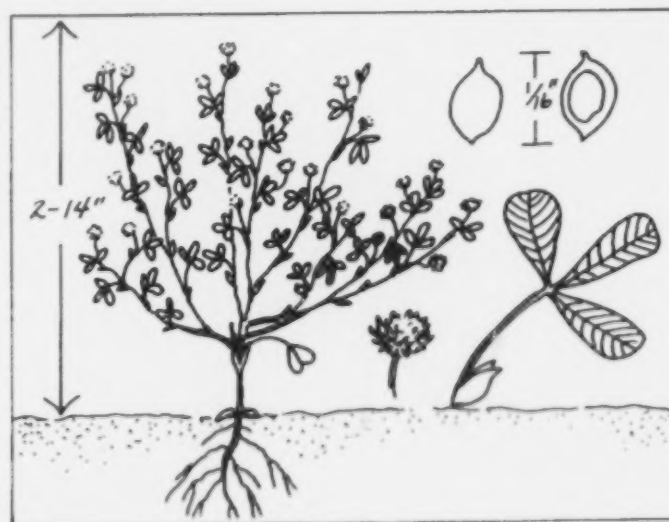


Korean lespedeza
Kummerowia stipulacea

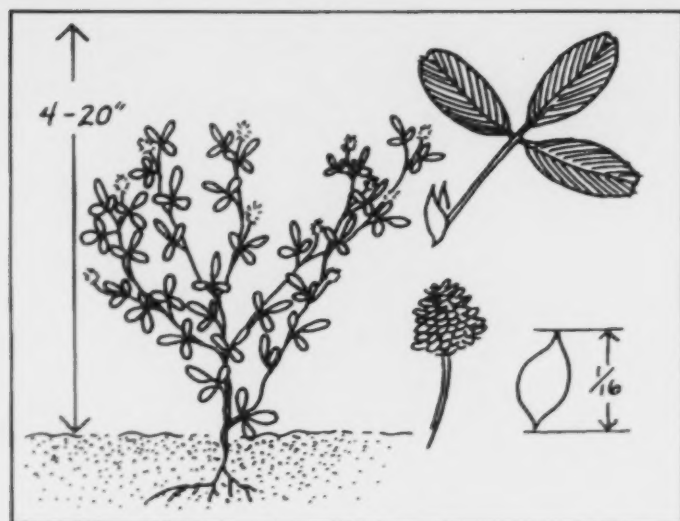


Lead plant
Amorpha canescens

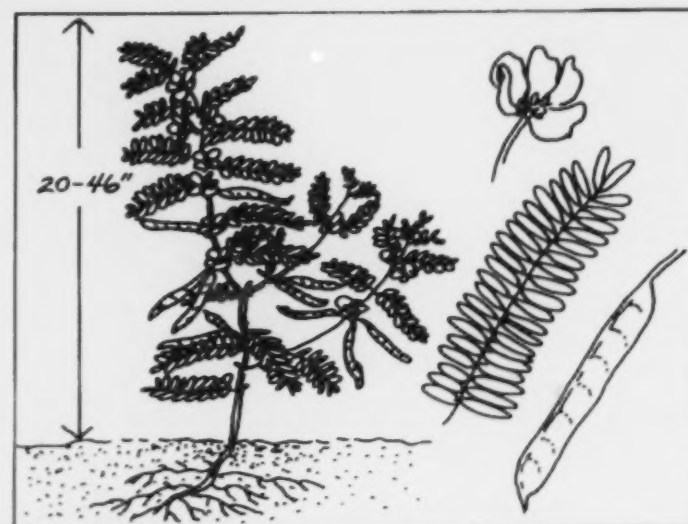
Legume Identification										
Common Name Botanical Name	Primary Use	Root Structure/ Modified Stems	Life Cycle	Plant Height	Petioles	Leaf Arrangement	Leaflet Shape	Leaflet Margin	Flower	Fruit
Little hop clover <i>Trifolium dubium</i>	forage in early spring pastures; food for quail, deer, rabbits	taproot	annual	2-14"	small stipules	pinnately trifoliate	oblongate	serrulate	yellow head with 5 to 15 florets	oblong, 1 seed
Low hop clover <i>Trifolium campestre</i>	forage	taproot	annual	4-20"	ovate stipules	pinnately trifoliate	oblong	denticulate on upper half	yellow head with 20 to 40 florets	1 seed
Partridge pea <i>Cassia chamaecrista</i>	food for quail, deer	taproot	annual	20-46"	stipules gradually tapering to tip	pinnate, 8 to 15 pairs	oblong	entire	yellow, showy	linear to oblong, smooth or few hairs, 1-3"
Red clover <i>Trifolium pratense</i>	forage; food for grouse, quail, deer, turkeys	deep taproot with many side branches producing runners	perennial	12-40" with hairy stems	hairy stipules connected to petioles for half their length	palmately trifoliate, hairy with reddish or darkened spots	obovate	entire	rose-red head with 25 to 80 florets	1 or 2 seeds, ovate



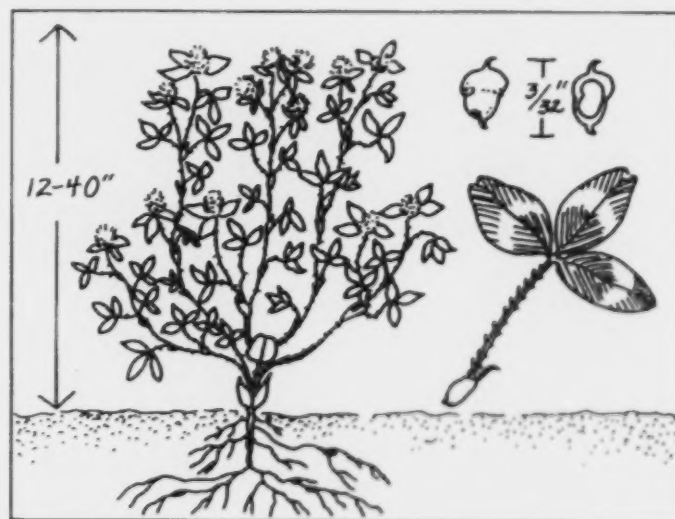
Little hop clover
Trifolium dubium



Low hop clover
Trifolium campestre

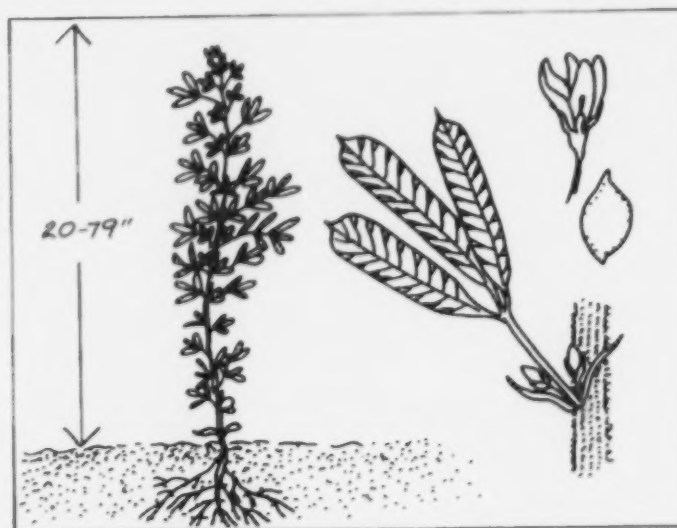


Partridge pea
Cassia chamaecrista



Red clover
Trifolium pratense

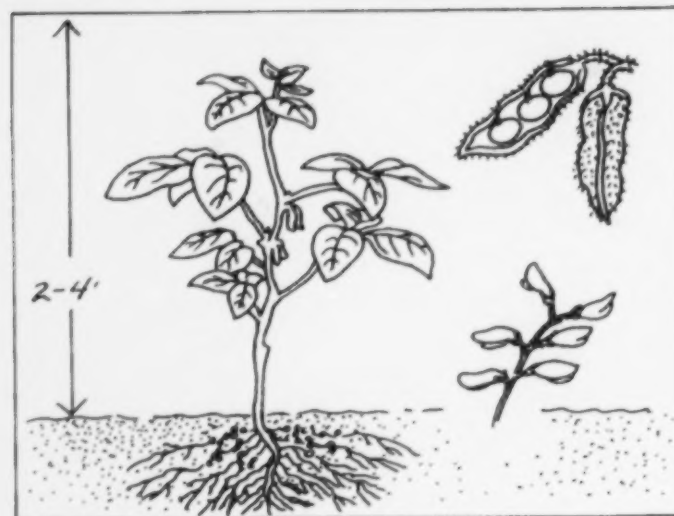
Legume Identification										
Common Name Botanical Name	Primary Use	Root Structure/ Modified Stems	Life Cycle	Plant Height	Petioles	Leaf Arrangement	Leaflet Shape	Leaflet Margin	Flower	Fruit
Sericea lespedeza or silky bush clover <i>Lepedeza cuneata</i>	food for rabbits	taproot	perennial	20-79" with hairy ridges on stem	small stipules	pinnately trifoliate	linear to oblong	entire	white or yellow, simple	soft hairs, very small
Slender lespedeza <i>Lepedeza virginica</i>	food for quail, deer, turkeys	deep-rooted taproot	perennial	12-40", slender and erect with few branches	thread-like stipules	pinnately trifoliate	linear	entire	purple raceme all along stems	small pods
Soybean <i>Glycine max</i>	crop; food for prairie chickens and rabbits	taproot	annual	2-4'	stipules	pinnately trifoliate	oval	entire	white or purple raceme with 8 to 16 florets	2 or 3 seeds, drooping, brown, hairy
Tick trefoil <i>Desmodium spp.</i>	food for quail, deer, turkeys	taproot leading to a fibrous root system	perennial	20-79", hooked hairs on stems	stipules nearly obsolete to small	pinnately trifoliate	orbicular	entire	purple or pinkish raceme	2 to 8 one-seeded segments



Sericea lespedeza or silky bush clover
Lepedeza cuneata



Slender lespedeza
Lespedeza virginica

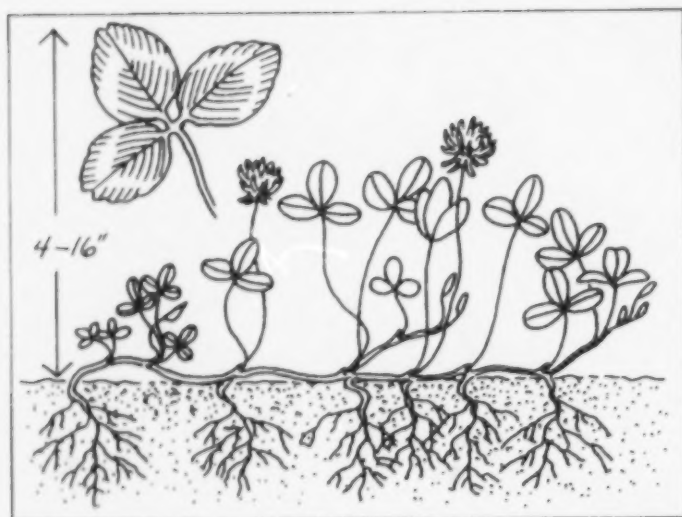


Soybean
Glycine max

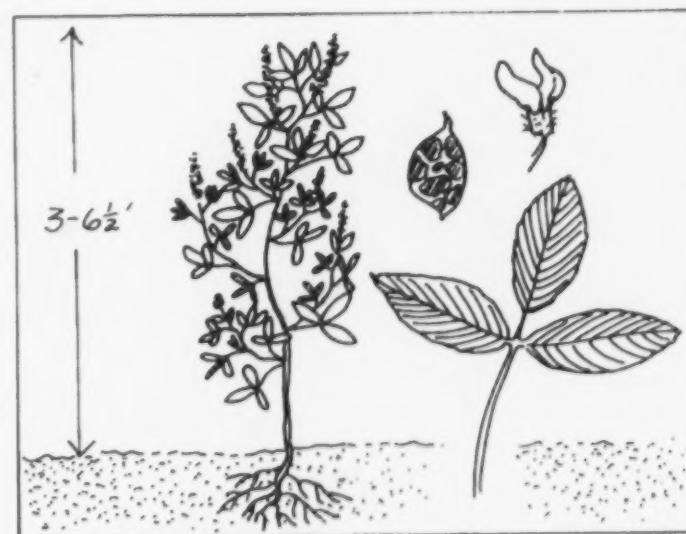


Tick trefoil
Desmodium spp.

Legume Identification										
Common Name Botanical Name	Primary Use	Root Structure/ Modified Stems	Life Cycle	Plant Height	Petioles	Leaf Arrangement	Leaflet Shape	Leaflet Margin	Flower	Fruit
White clover <i>Trifolium repens</i>	forage; food for quail, deer, rabbits, turkeys	taproot and stolons	perennial	4-16" long	closed stipules forming a membranaceous sheath	palmately trifoliate, white or yellow mark with "M" or "W"	obovate	sermulate	white head with 20 to 40 florets	3 seeds, oblong to linear
Yellow sweet clover <i>Melilotus officinalis</i>	food for deer, rabbits, turkeys	deep taproot	biennial	3-6½'	stipules	pinnately trifoliate	lanceolate to oblong	more than half serrated	yellow raceme	smooth, cross-veined, honey-combed



White clover
Trifolium repens



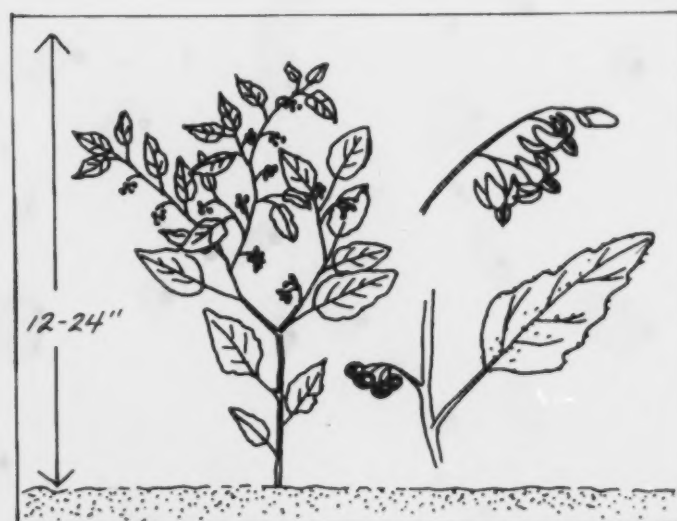
Yellow sweet clover
Melilotus officinalis

Forbs

Black nightshade - *Solanum americanum*
 Bracted plantain - *Plantago aristata*
 Buckwheat - *Fagopyrum esculentum*
 Bull nettle - *Cnidioscolus texanus*
 Bull thistle - *Cirsium vulgare*
 Bur cucumber - *Sicyos angulatus*
 Butterfly milkweed - *Asclepias tuberosa*
 Canada thistle - *Cirsium arvense*
 Cinquefoil - *Potentilla simplex*
 Common chickweed - *Stellaria media*
 Common chicory - *Cichorium intybus*
 Common cocklebur - *Xanthium strumarium*
 Common milkweed - *Asclepias syriaca*
 Common morning glory - *Ipomoea purpurea*
 Common plantain - *Plantago major*
 Common ragweed - *Ambrosia artemisiifolia* L.
 Common sunflower - *Helianthus annuus*
 Common yarrow - *Achillea millefolium*
 Corn cockle - *Agrostemma githago*
 Cotton - *Gossypium hirsutum*
 Croton - *Croton monanthogynus*
 Daisy fleabane - *Erigeron strigosus*
 Dandelion - *Taraxacum officinale*
 Field bindweed - *Convolvulus arvensis*
 Four-leaf milkweed - *Asclepias quadrifolia*
 Giant ragweed - *Ambrosia trifida* L.
 Hedge bindweed - *Convolvulus sepium*
 Hemp - *Cannabis sativa*
 Henbit - *Lamium amplexicaule*
 Horse nettle - *Solanum carolinense*
 Ironweed - *Vernonia baldwini*

Ivyleaf morning glory - *Ipomoea hederacea*
 Jimsonweed - *Datura stramonium*
 Kochia or burning bush - *Kochia scoparia*
 Lamb's quarters - *Chenopodium album*
 Lance-leaf ragweed - *Ambrosia bidentata*
 Musk thistle - *Carduus nutans*
 Ox-eye daisy - *Chrysanthemum leucanthemum*
 Pale dock - *Rumex altissimus*
 Pennsylvania smartweed - *Polygonum pennsylvanicum*
 Pepper grass - *Lepidium virginicum*
 Pigweed - *Amaranthus spp.*
 Prairie dogbane - *Apocynum cannabinum*
 Prairie goldenrod - *Solidago missouriensis*
 Prickly lettuce - *Lactuca serriola*
 Prickly sida - *Sida spinosa*
 Queen Anne's lace or wild carrot - *Daucus carota*
 Sheep sorrel or field sorrel - *Rumex acetosella*
 Shepherd's purse - *Capsella bursa-pastoris*
 Smartweed - *Polygonum lapathifolium*
 Tobacco - *Nicotiana tabacum*
 Tall thistle - *Cirsium altissimum*
 Three-seeded mercury - *Acalypha ostryaefolia*
 Velvetleaf - *Abutilon theophrasti*
 Venice mallow or flower of an hour - *Hibiscus trionum*
 Water hemp - *Amaranthus tamariscinus*
 White avens - *Geum canadense*
 White mustard - *Brassica hirta*
 Wild cucumber - *Echinocystis lobata*
 Wild garlic - *Allium canadense*
 Wild strawberry - *Fragaria virginiana*

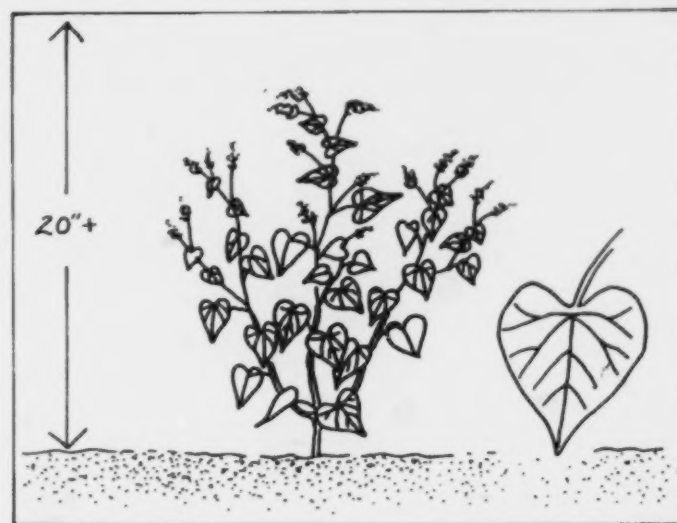
Forb Identification										
Common Name Botanical Name	Life Cycle	Plant Height	Root Structure/ Modified Stems	Leaf Type	Leaf Arrangement	Leaf Shape	Leaf Margin	Leaf Venation	Leaf Surface	Flower/Fruit
Black nightshade <i>Solanum americanum</i>	annual	12-24"	taproot	simple	alternate	ovate	dentate	pinnate	smooth with few hairs near veins, midrib, and margins	flowers -- white, star-shaped, 1/2" wide, in small drooping clusters; fruit -- black, 1/2" diameter
Bracted plantain <i>Plantago aristata</i>	annual	6-18"	fibrous	simple	basal	oblanceolate	entire	parallel	hairy	flowers -- spike, numerous florets
Buckwheat <i>Fagopyrum esculentum</i>	annual	20"+	taproot	simple	alternate	ovate, heart-shaped with stipules	entire	pinnate	smooth with hair at the nodes	flowers -- axillary raceme
Bull nettle <i>Cnidioscolus texanus</i>	perennial	12-20"	stolons	simple	alternate	orbicular	deeply lobed, with 3 to 5 lobes	palmate	sparse, stinging hairs	flowers -- terminal, white, fragrant, trumpet-shaped



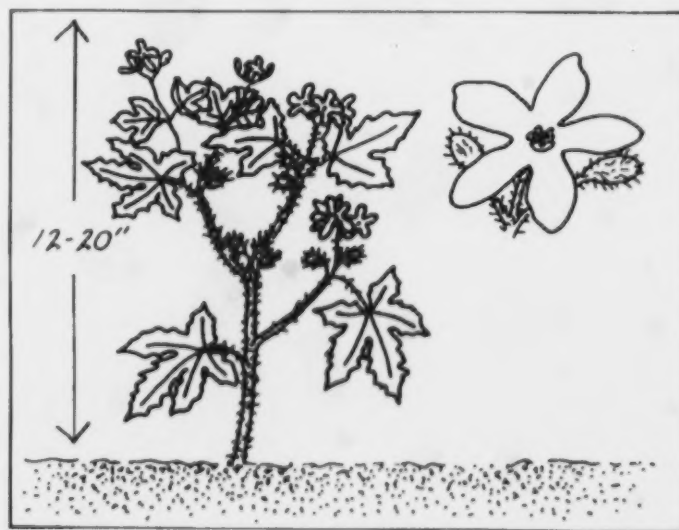
Black nightshade
Solanum americanum



Bracted plantain
Plantago aristata

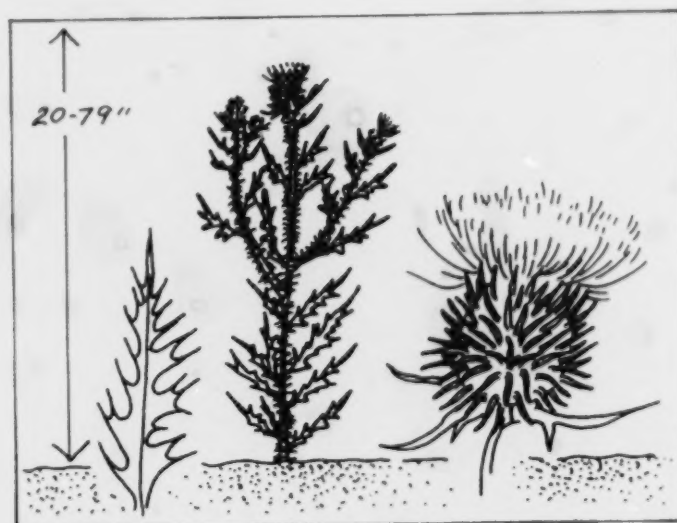


Buckwheat
Fagopyrum esculentum

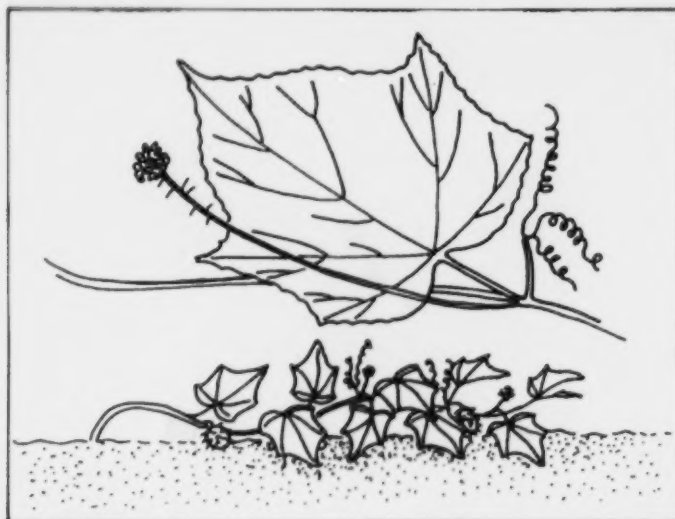


Bull nettle
Cnidoscolus texanus

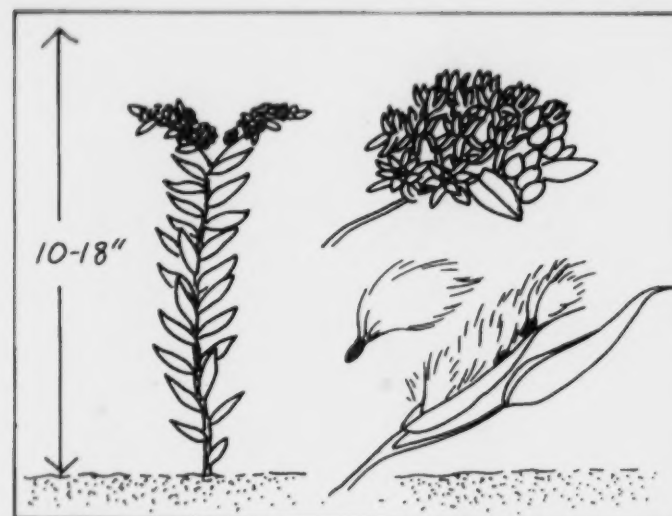
Forb Identification										
Common Name Botanical Name	Life Cycle	Plant Height	Root Structure/ Modified Stems	Leaf Type	Leaf Arrangement	Leaf Shape	Leaf Margin	Leaf Venation	Leaf Surface	Flower/Fruit
Bull thistle <i>Cirsium vulgare</i>	biennial	20-79"	short, fleshy taproot	simple	alternate from winged prickly stem	oblanceolate with lobes that are linear to lanceolate	irregularly incised, tipped with weak spines	pinnate	smooth with fine short yellowish prickles on top	flowers -- terminal head, dark purple
Bur cucumber <i>Sicyos angulatus</i>	annual	climbing vine	fibrous	simple	alternate	orbicular, forked tendrils	dentate, shallowly lobed with 3 to 5 lobes	palmate	smooth	fruit -- ovoid and dark with prickly bristles
Butterfly milkweed <i>Asclepias tuberosa</i>	perennial	10-18"	deep, woody	simple	alternate	linear, attached directly to the stem	entire	pinnate	long, soft hairs	flowers -- red-orange florets forming a large terminal umbel
Canada thistle <i>Cirsium arvense</i>	perennial	2-5'	deep taproot	simple	alternate	oblong	incised, spiny	pinnate	sparse hairs on upper surface, dense hairs on lower surface	flowers -- pink, male or female heads



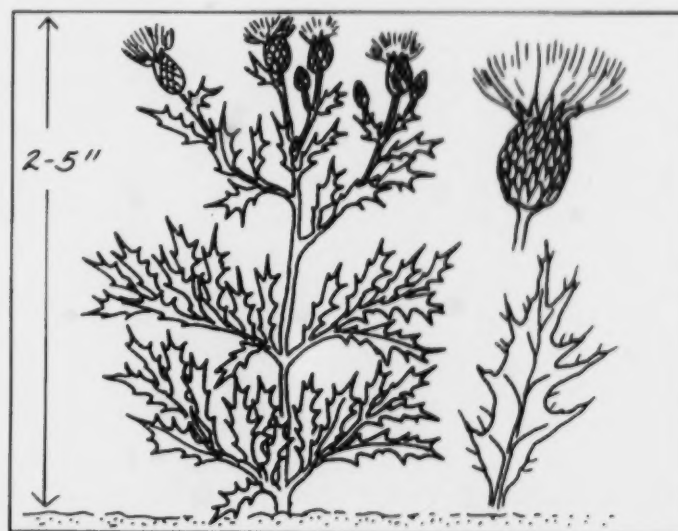
Bull thistle
Cirsium vulgare



Bur cucumber
Sicyos angulatus



Butterfly milkweed
Asclepias tuberosa

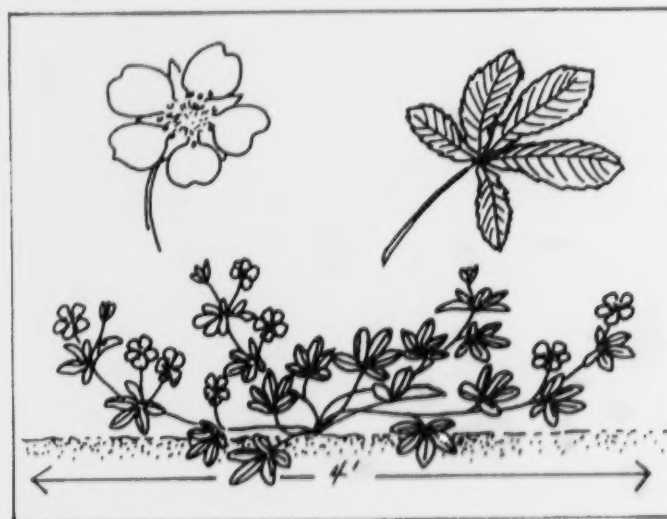


Canada thistle
Cirsium arvense

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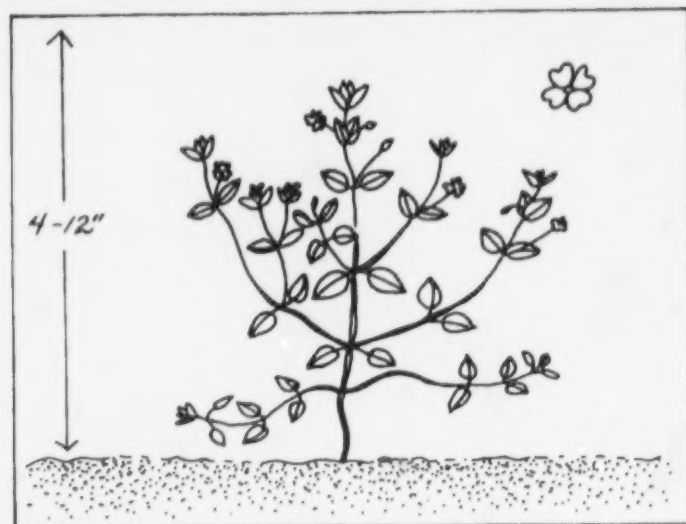
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Forb Identification										
Common Name Botanical Name	Life Cycle	Plant Height	Root Structure/ Modified Stems	Leaf Type	Leaf Arrangement	Leaf Shape	Leaf Margin	Leaf Venation	Leaf Surface	Flower/Fruit
Cinquefoil <i>Potentilla simplex</i>	perennial	spreading, 4" long	rhizomes	palmately compound	alternate	oblongate	serrulate	pinnate leaflets	hairy, sometimes white underneath	flowers -- from nodes, small and yellow with 5 petals
Common chickweed <i>Stellaria media</i>	annual	4-12"	stolons	simple	opposite	broadly ovate	entire	parallel	smooth with hair on one side of the petioles	flowers -- small and white with 5 deeply notched petals
Common chicory <i>Cichorium intybus</i>	perennial	2-5'+	taproot	simple	alternate	linear	slightly lobed or entire	pinnate	rigid, rough	flowers -- blue ray flowers sporadically lining the upper stem
Common cocklebur <i>Xanthium strumarium</i>	annual	18-30"	taproot	simple	alternate from stems with small rough hairs	ovate	dentate to sinuate	pinnate	smooth	flowers -- male and female found separately on same plant, fruit -- small, hard, oval-shaped bur with spines, 1/4" long



Cinquefoil
Potentilla simplex

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Common chickweed
Stellaria media



Common chicory
Cichorium intybus

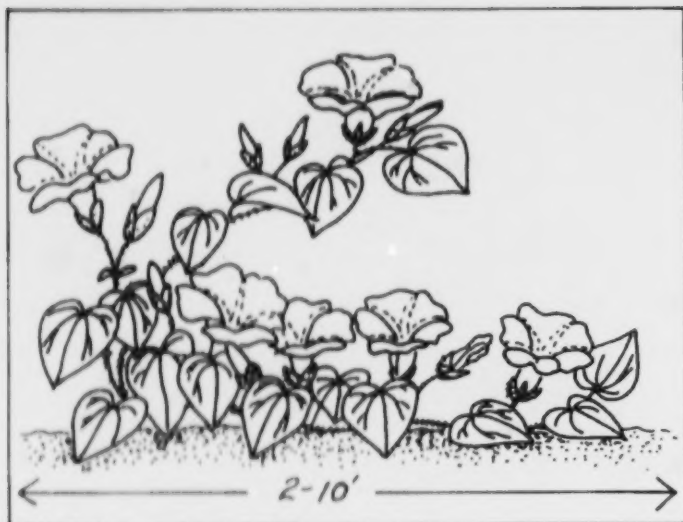


Common cocklebur
Xanthium strumarium

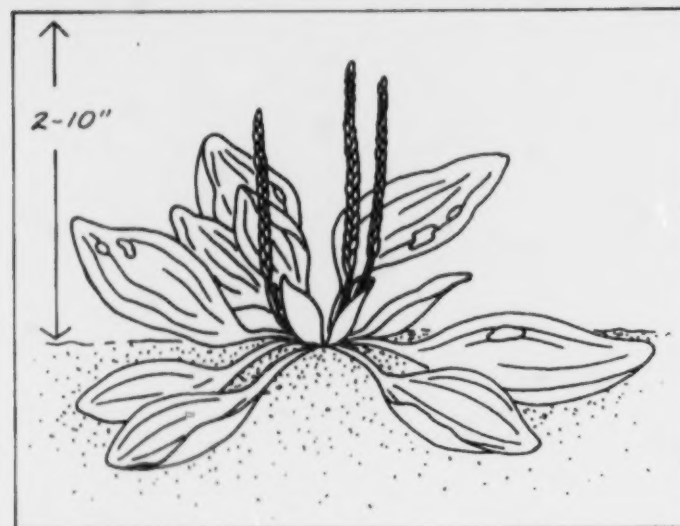
Forb Identification										
Common Name Botanical Name	Life Cycle	Plant Height	Root Structure/ Modified Stems	Leaf Type	Leaf Arrangement	Leaf Shape	Leaf Margin	Leaf Venation	Leaf Surface	Flower/Fruit
Common milkweed <i>Asclepias syriaca</i>	perennial	2-5'	rhizomes	simple	opposite	broadly ovate to oblong	entire	pinnate	prominent veins and few hairs	flowers -- pink to white, sweet smelling, forming ball-like clusters at stem
Common morning glory <i>Ipomoea purpurea</i>	annual	2-10'	fibrous, fast spreading	simple	alternate from hairy stems	ovate	3 lobes	palmate	smooth	flowers -- white with dark purple center, funnel-shaped, 2-3" in diameter
Common plantain <i>Plantago major</i>	annual	2-10"	fibrous	simple	basal	broadly ovate	entire	parallel	smooth or with few long hairs	flowers -- spikes
Common ragweed <i>Ambrosia artemisiifolia</i> L.	annual	1-3'	taproot	simple	opposite on lower plant, alternate on upper plant	ovate	deeply incised	pinnate	rough leaves and stem	flowers -- male and female found separately on same plant



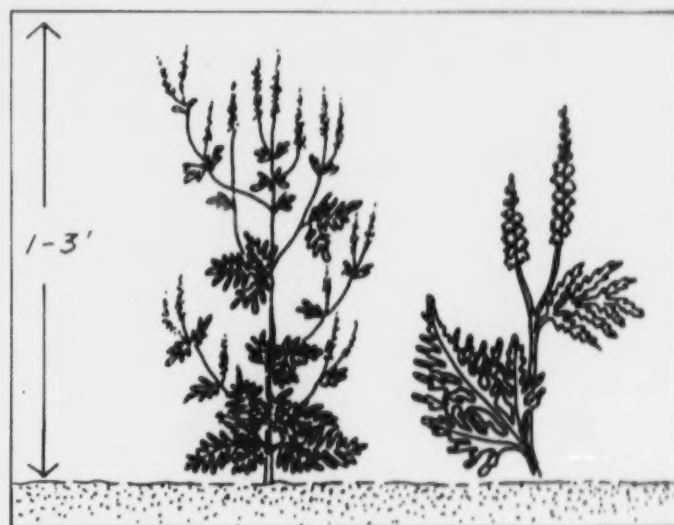
Common milkweed
Asclepias syriaca



Common morning glory
Ipomoea purpurea



Common plantain
Plantago major

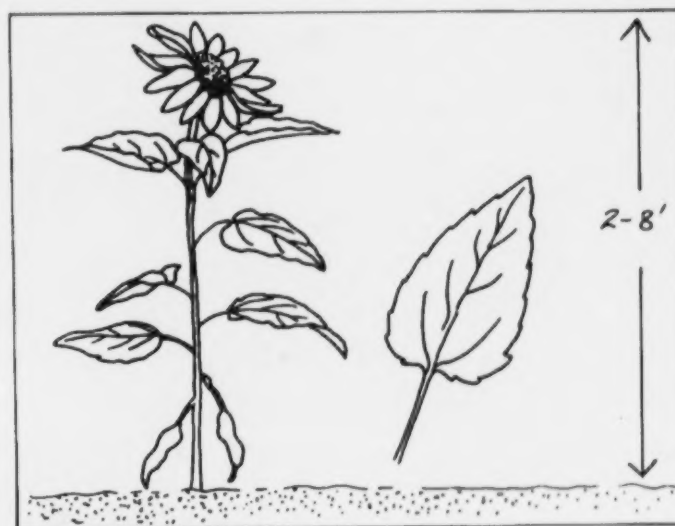


Common ragweed
Ambrosia artemisiifolia L.

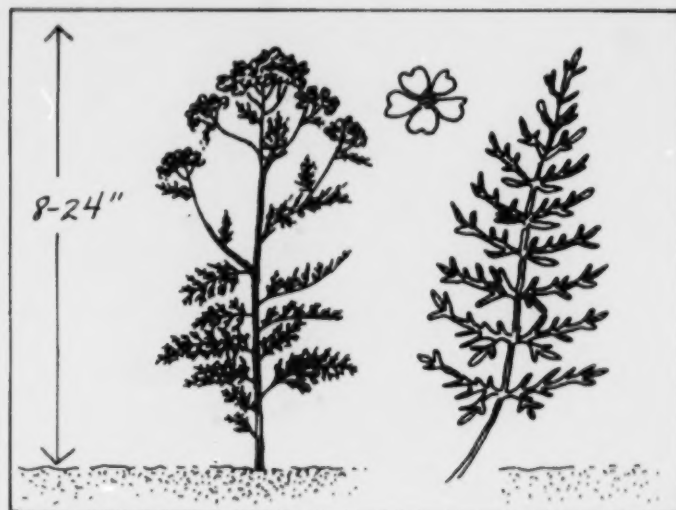
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Forb Identification										
Common Name Botanical Name	Life Cycle	Plant Height	Root Structure/ Modified Stems	Leaf Type	Leaf Arrangement	Leaf Shape	Leaf Margin	Leaf Venation	Leaf Surface	Flower/Fruit
Common sunflower <i>Helianthus annuus</i>	annual	2-8'	fibrous	simple	alternate from hairy stem	ovate	dentate	pinnate	rough	flowers -- from nodes, 1-5" in diameter, 17 yellow ray florets surrounding brown disk florets
Common yarrow <i>Achillea millefolium</i>	perennial	8-24"	rhizomes	bipinnate	alternate	lanceolate	entire	pinnate	lacy, rough	flowers -- white or (rarely) pink, corymb with many heads
Corn cockle <i>Agrostemma githago</i>	annual	2-3'	taproot	simple	opposite	slender, linear	entire	parallel	hairy at base	flowers -- large and purple with narrow green sepals
Cotton <i>Gossypium hirsutum</i>	annual	2-5'	deep taproot	simple	alternate	orbicular	entire, deeply lobed with 3 lobes	palmate	hairy	flowers -- alternate sides of fruiting branch, 5 large sepals, 5 petals



Common sunflower
Helianthus annuus



Common yarrow
Achillea millefolium

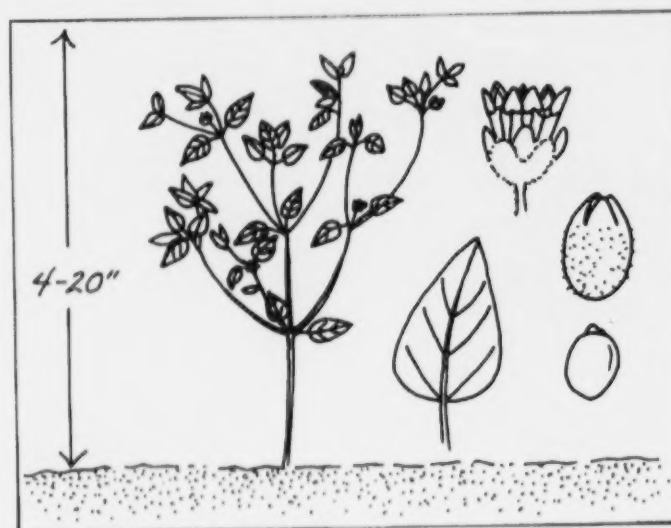


Corn cockle
Agrostemma githago



Cotton
Gossypium hirsutum

Forb Identification										
Common Name Botanical Name	Life Cycle	Plant Height	Root Structure/ Modified Stems	Leaf Type	Leaf Arrangement	Leaf Shape	Leaf Margin	Leaf Venation	Leaf Surface	Flower/Fruit
Croton <i>Croton monanthogynus</i>	annual	4-20"	taproot	simple	alternate	ovate	entire	pinnate	smooth	flowers -- terminal raceme
Daisy fleabane <i>Erigeron strigosus</i>	annual	16-28"	shallow roots, rhizomes	simple	alternate	oblanceolate to linear	entire to serrate	pinnate	smooth or a few long hairs	flowers -- terminal heads in cluster, white or pinkish to blue
Dandelion <i>Taraxacum officinale</i>	perennial	6-8"	thick taproot	simple	basal	oblanceolate	variously lobed to points	pinnate	smooth or lightly hairy	flowers -- yellow ray flowers 1-2" in diameter
Field bindweed <i>Convolvulus arvensis</i>	perennial	2-7' vine	widespread rhizomes	simple	alternate	ovate with pointed lobes at base, arrowhead-shaped	entire to undulate	pinnate	smooth or very few hairs	flowers -- white or pink, funnel- shaped, 1" across, axillary



Croton
Croton monanthogynus



Daisy fleabane
Erigeron strigosus



Dandelion
Taraxacum officinale



Field bindweed
Convolvulus arvensis

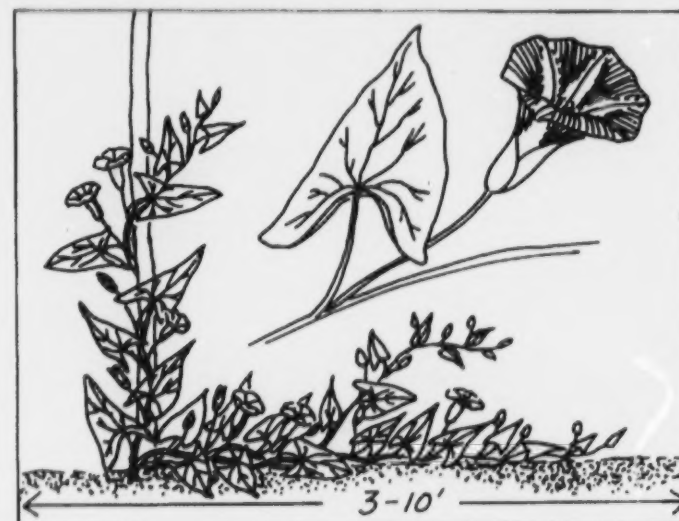
Forb Identification										
Common Name Botanical Name	Life Cycle	Plant Height	Root Structure/ Modified Stems	Leaf Type	Leaf Arrangement	Leaf Shape	Leaf Margin	Leaf Venation	Leaf Surface	Flower/Fruit
Four-leaf milkweed <i>Asclepias quadrifolia</i>	perennial	10-24"	rhizomes	simple	opposite, one internode missing to form a false whorl	lanceolate to ovate	entire	pinnate	smooth or few short hairs	flowers -- green to purple-tinged, terminal panicle, drooping
Giant ragweed <i>Ambrosia trifida</i> L.	annual	3-10'	taproot	simple	opposite	ovate	3 to 5 cleft lobes, serrate or entire	pinnate	smooth or few hairs	flowers -- raceme, separate male and female flowers
Hedge bindweed <i>Convolvulus sepium</i>	perennial	vine twining around other plants, 3-10'	rhizomes	simple	alternate	ovate to lanceolate with rounded lobes at base, arrowhead-like	entire	pinnate	covered with fine small hairs	flowers -- white or pinkish, 1½-2" diameter, petals fused together in funnel shape
Hemp <i>Cannabis sativa</i>	annual	2-10'	taproot	palmate, compound, 5 to 9 leaflets	opposite at base, alternate on upper plant	linear to linear- lanceolate	dentate	pinnate leaflets	hairy	flowers -- male and female flowers on separate plants



Four-leaf milkweed
Asclepias quadrifolia



Giant ragweed
Ambrosia trifida L.



Hedge bindweed
Convolvulus sepium



Hemp
Cannabis sativa

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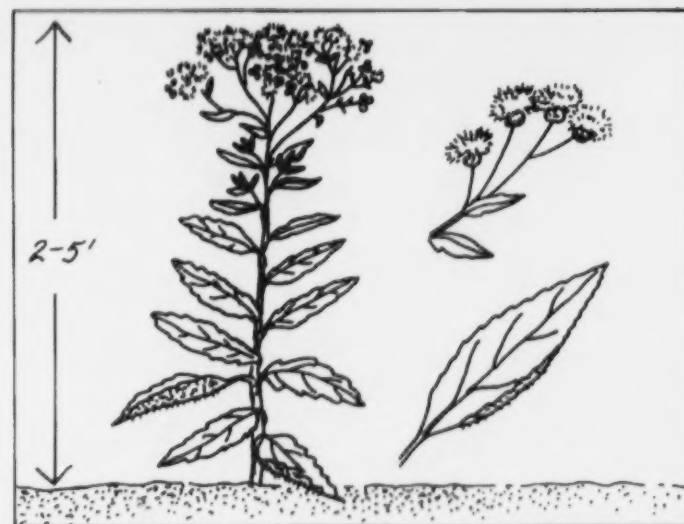
Forb Identification										
Common Name Botanical Name	Life Cycle	Plant Height	Root Structure/ Modified Stems	Leaf Type	Leaf Arrangement	Leaf Shape	Leaf Margin	Leaf Venation	Leaf Surface	Flower/Fruit
Henbit <i>Lamium amplexicaule</i>	perennial	4-14"	short taproot	simple	opposite	broadly ovate to orbicular	lobed	palmate	short hairs	flowers -- pinkish purple, tubular
Horse nettle <i>Solanum carolinense</i>	perennial	1-4'	rhizomes	simple	alternate from prickly stems	oblong	lobed to undulate	pinnate	yellow prickles on midrib and veins of lower surface	flowers -- white to bluish white, 5 lobes, 1" diameter, clusters
Ironweed <i>Vernonia baldwini</i>	perennial	2-5'	fibrous, deep	simple	alternate from stiff woody stems densely covered with short hairs	lanceolate, 1-2" wide, 4-8" long	dentate	pinnate	densely hairy on lower surface	flowers -- 13 to 34 reddish purple florets densely massed together
Ivyleaf morning glory <i>Ipomoea hederacea</i>	annual	climbing ivy	fibrous	simple	alternate	ovate	entire, deeply lobed with 3 lobes	palmate	densely to sparsely covered with short hairs	flowers -- funnel-shaped, light blue with inside white or pale yellow, 1-2" diameter



Henbit
Lamium amplexicaule



Horse nettle
Solanum carolinense



Ironweed
Vernonia baldwini

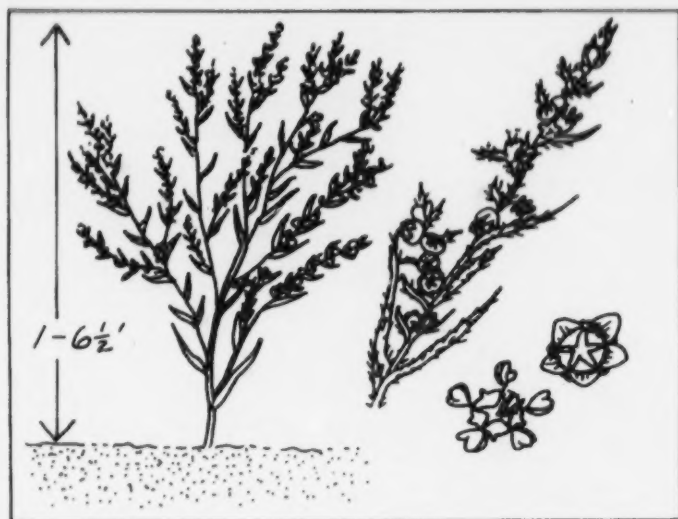


Ivyleaf morning glory
Ipomoea hederacea

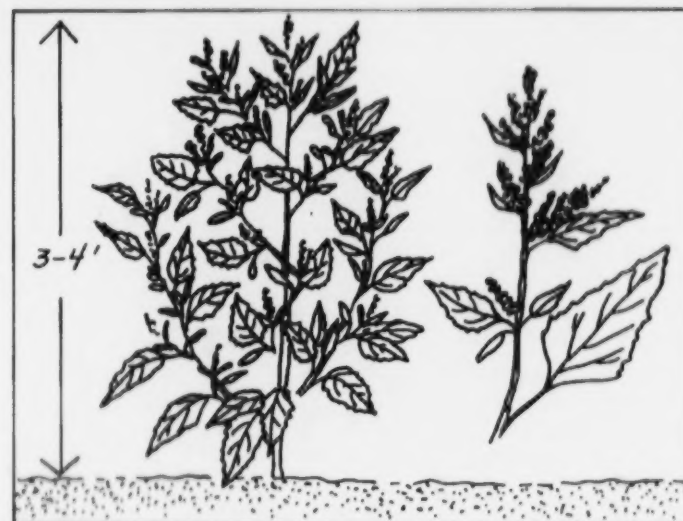
Forb Identification										
Common Name Botanical Name	Life Cycle	Plant Height	Root Structure/ Modified Stems	Leaf Type	Leaf Arrangement	Leaf Shape	Leaf Margin	Leaf Venation	Leaf Surface	Flower/Fruit
Jimsonweed <i>Datura stramonium</i>	annual	2-4'	thick taproot	simple	alternate	ovate	doubly serrate	pinnate	smooth or fine, short hairs	flowers -- large, funnel-shaped, white to pinkish, 2-5" long
Kochia or burning bush <i>Kochia scoparia</i>	annual	1-6½'	fibrous	simple	alternate	linear to lanceolate on lower plant, oblanceolate to obovate on upper plant	entire	pinnate	scattered with long hairs	flowers -- axillary spikes
Lamb's quarters <i>Chenopodium album</i>	annual	3-4'	taproot; square stem	simple	alternate	ovate	incised	pinnate	smooth, white, mealy-coated	flowers -- small, green, without petals, axillary
Lance-leaf ragweed <i>Ambrosia bidentata</i>	annual	1-4'	taproot	simple	alternate from rough, hairy stems	lanceolate	deeply cut, rough lobes	pinnate	mostly smooth with few hairs	flowers -- male and female on separate plants



Jimsonweed
Datura stramonium



Kochia or burning bush
Kochia scoparia

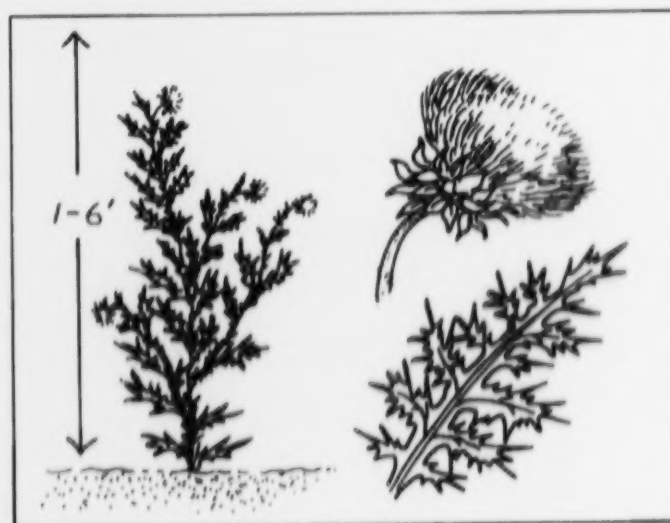


Lamb's quarters
Chenopodium album



Lance-leaf ragweed
Ambrosia bidentata

Forb Identification										
Common Name Botanical Name	Life Cycle	Plant Height	Root Structure/ Modified Stems	Leaf Type	Leaf Arrangement	Leaf Shape	Leaf Margin	Leaf Venation	Leaf Surface	Flower/Fruit
Musk thistle <i>Carduus nutans</i>	biennial	1-6'	taproot	simple	basal; also alternate on stem	lanceolate	deeply lobed	pinnate	spines on margins	flowers -- rose to purple, terminal, 1½-3" in diameter
Ox-eye daisy <i>Chrysanthemum leucanthemum</i>	perennial	1-3'	rhizomes	simple	alternate	linear to oblanceolate	lobed	pinnate	smooth	flower -- 1-2" in diameter, white ray flower and yellow disk flower
Pale dock <i>Rumex altissimus</i>	perennial	up to 40" tall	rhizomes	simple	alternate	lanceolate	entire	pinnate	smooth	flowers -- terminal and axillary spikes, greenish to reddish brown
Pennsylvania smartweed <i>Polygonum pennsylvanicum</i>	annual	1-5'	taproot	simple	alternate	lanceolate	entire	pinnate	smooth with very few short hairs	flowers -- dense, small, rose or pink flowers throughout plant



Musk thistle
Carduus nutans

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Ox-eye daisy
Chrysanthemum leucanthemum



Pale dock
Rumex altissimus



Pennsylvania smartweed
Polygonum pennsylvanicum

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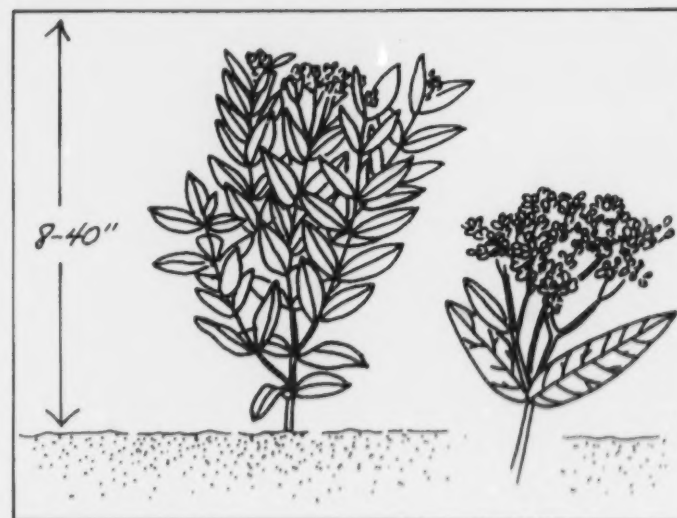
Forb Identification										
Common Name Botanical Name	Life Cycle	Plant Height	Root Structure/ Modified Stems	Leaf Type	Leaf Arrangement	Leaf Shape	Leaf Margin	Leaf Venation	Leaf Surface	Flower/Fruit
Pepper grass <i>Lepidium virginicum</i>	annual	10-20"	taproot	simple	alternate	oblanceolate to linear	sharply serrate	pinnate	smooth or very few short hairs	flowers -- raceme, white, numerous, up to 4" long
Pigweed <i>Amaranthus spp.</i>	annual	up to 8'	taproot	simple	alternate	ovate to lanceolate	entire to sinuate	pinnate	smooth	flowers -- small green florets in terminal axillary spikes
Prairie dogbane <i>Apocynum cannabinum</i>	perennial	8-40"	rhizomes	simple	opposite or alternate	ovate	entire	pinnate	long soft hairs	flowers -- terminal, white to green, small, clustered
Prairie goldenrod <i>Solidago missouriensis</i>	perennial	2-4'	rhizomes	simple	alternate	oval, oblong, or linear	serrulate	pinnate	rough with inconspicuous hairs	flowers -- many small golden heads, axillary, panicle, or corymb



Pepper grass
Lepidium virginicum



Pigweed
Amaranthus spp.



Prairie dogbane
Apocynium cannabinum

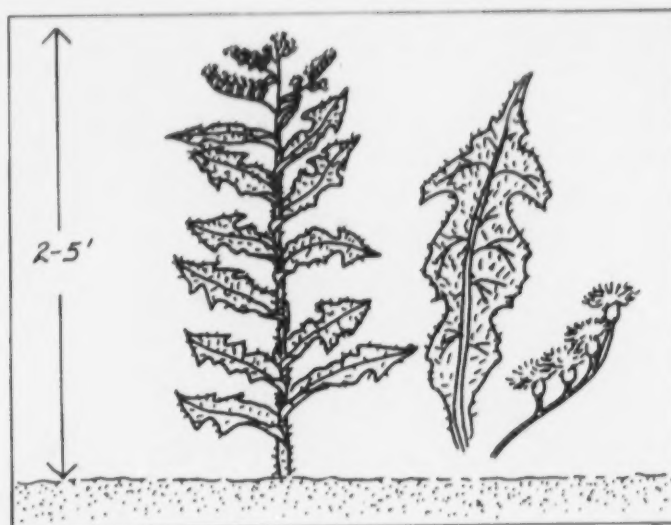


Prairie goldenrod
Solidago missouriensis

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Forb Identification										
Common Name Botanical Name	Life Cycle	Plant Height	Root Structure/ Modified Stems	Leaf Type	Leaf Arrangement	Leaf Shape	Leaf Margin	Leaf Venation	Leaf Surface	Flower/Fruit
Prickly lettuce <i>Lactuca serriola</i>	biennial	2-5'	taproot, fibrous at maturity	simple	alternate	obovate	deeply pinnate, serrulate lobes	pinnate	rough, prickly	flowers -- yellow with dark blue stripe
Prickly sida <i>Sida spinosa</i>	annual	1-2'	taproot	simple	alternate from hairy stem	oblong	doubly serrate	pinnate	smooth with a few hairs near stem	flowers -- 5 pale yellow petals, solitary or clustered in axils of leaves
Queen Anne's lace or wild carrot <i>Daucus carota</i>	biennial	1-3'	taproot	compound pinnate	alternate	lanceolate to linear leaflets	entire, with a few split	pinnate	smooth	flowers -- large umbel, white florets, 5 petals
Sheep sorrel or field sorrel <i>Rumex acetosella</i>	perennial	6-18"	rhizomes	simple	alternate	linear with 2 perpendicular basal lobes	entire	pinnate	smooth, fleshy	flowers -- raceme, yellow or red, male and female on separate plants



Prickly lettuce
Lactuca serriola



Prickly sida
Sida spinosa



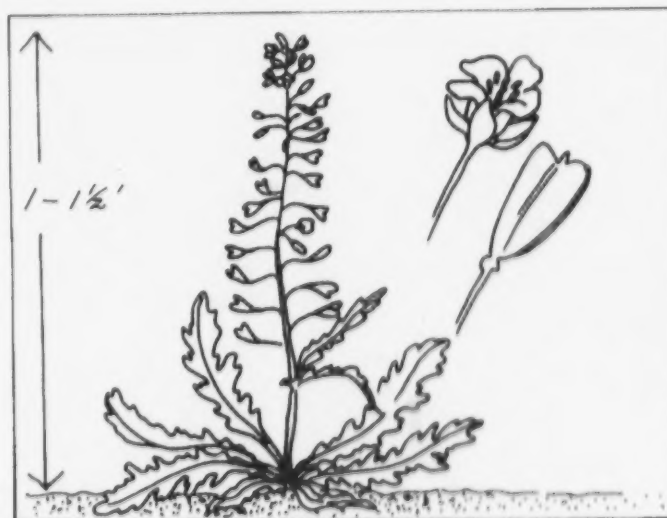
Queen Anne's lace or wild carrot
Daucus carota



Sheep sorrel or field sorrel
Rumex acetosella

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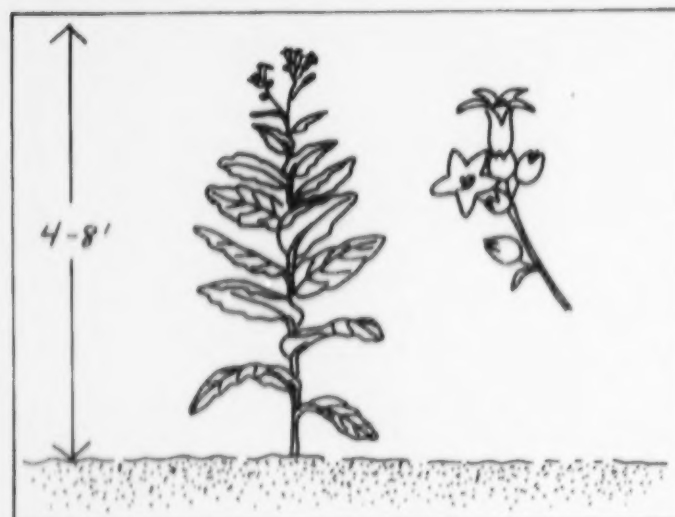
Forb Identification										
Common Name Botanical Name	Life Cycle	Plant Height	Root Structure/ Modified Stems	Leaf Type	Leaf Arrangement	Leaf Shape	Leaf Margin	Leaf Venation	Leaf Surface	Flower/Fruit
Shepherd's purse <i>Capsella bursa-pastoris</i>	annual	1-1 ½'	taproot	simple	basal; also alternate on stem	basal -- oblong; stem -- lanceolate to linear	basal -- coarsely lobed; stem -- entire	pinnate	smooth	flowers -- small white 4-petaled racemes
Smartweed <i>Polygonum lapathifolium</i>	annual	3'+	taproot	simple	alternate	lanceolate to linear	entire	pinnate	smooth	flowers -- raceme, drooping, dense, white, green, or roseate in color
Tabacco <i>Nicotiana tabacum</i>	annual	4-8'	taproot	simple	alternate	oval, 3-4' long, 1' wide	serrate	pinnate	sticky, covered with soft downy hairs	flowers -- pink or rose tubular terminal panicle
Tail thistle <i>Cirsium altissimum</i>	perennial	3-8'	fleshy taproot	simple	alternate	oblanceolate	doubly serrulate	pinnate	smooth on upper plant, dense white hairs on lower plant	flowers -- terminal heads, dark purple on lower part of flower



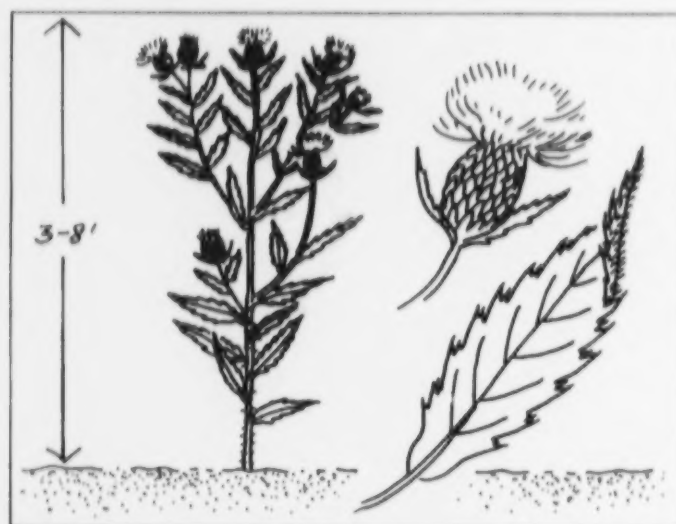
Shepherd's purse
Capsella bursa-pastoris



Smartweed
Polygonum lapathifolium



Tabacco
Nicotiana tabacum

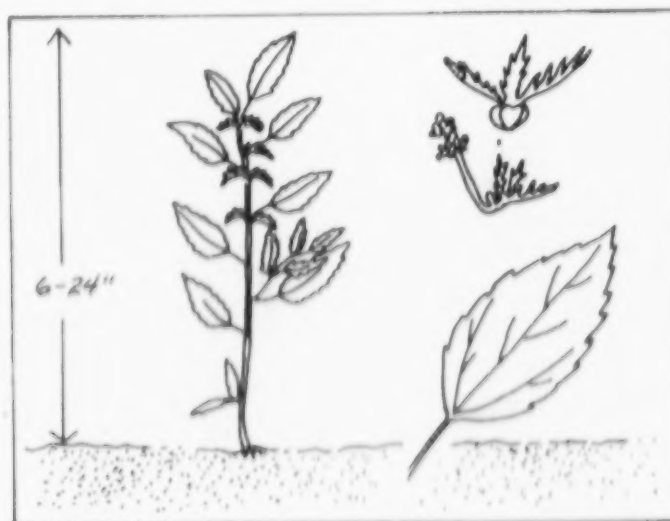


Tall thistle
Cirsium altissimum

351

352

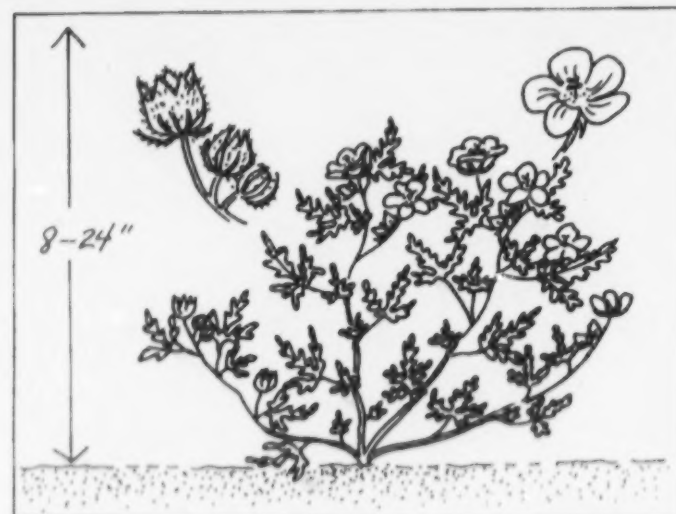
Forb Identification										
Common Name Botanical Name	Life Cycle	Plant Height	Root Structure/ Modified Stems	Leaf Type	Leaf Arrangement	Leaf Shape	Leaf Margin	Leaf Venation	Leaf Surface	Flower/Fruit
Three-seeded mercury <i>Acalypha ostryaefolia</i>	annual	6-24"	taproot	simple	alternate	oval to oblong	dentate	palmate	smooth or with few short hairs	flowers -- axillary spikes
Velvetleaf <i>Abutilon theophrasti</i>	annual	6-8'	taproot	simple	alternate	orbicular, heart-shaped	entire	palmate	hairy, velvety	flowers -- yellow, 5 petals, $\frac{3}{4}$ " diameter
Venice mallow or flower of an hour <i>Hibiscus trionum</i>	perennial	8-24"	taproot, fibrous	palmate, compound	opposite	3 to 7 lanceolate leaflets palmately connected	leaflets lobed or incised	palmate with 3 leaflets	smooth	flowers -- grows from nodes; 5 petals, whitish yellow with purple base and edge
Water hemp <i>Amaranthus tamariscinus</i>	annual	1-3'	taproot	simple	alternate	oval, may have long petiole, rounded tip	entire	pinnate	smooth	flowers -- terminal spike and axillary clusters



Three-seeded mercury
Acalypha ostryaefolia



Velvetleaf
Abutilon theophrasti



Venice mallow or flower of an hour
Hibiscus trionum

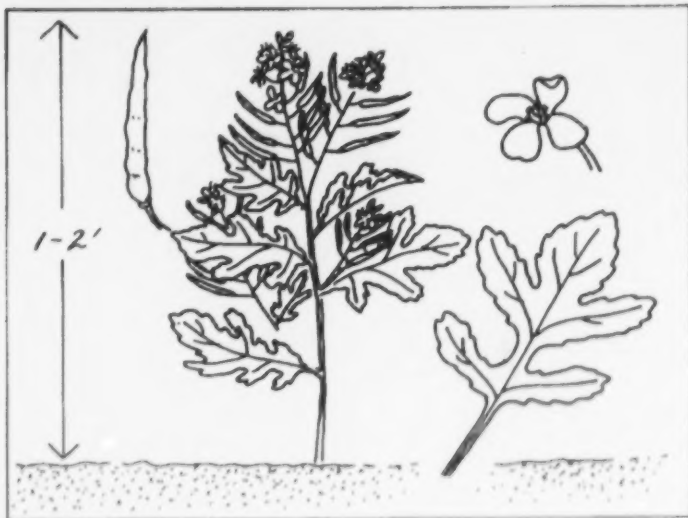


Water hemp
Amaranthus tamariscinus

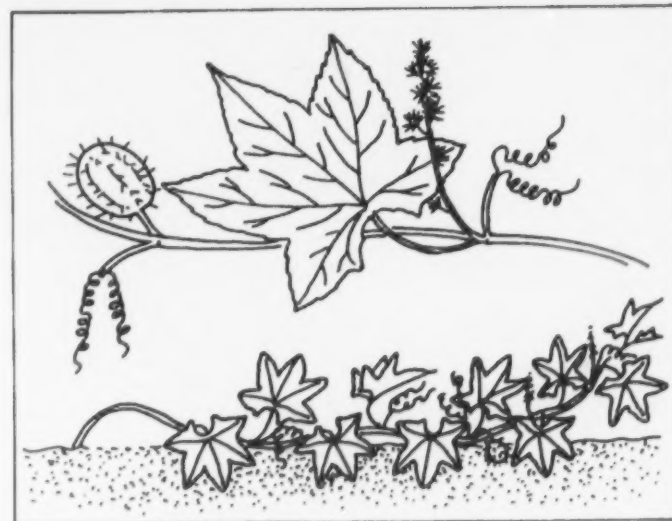
Forb Identification										
Common Name Botanical Name	Life Cycle	Plant Height	Root Structure/ Modified Stems	Leaf Type	Leaf Arrangement	Leaf Shape	Leaf Margin	Leaf Venation	Leaf Surface	Flower/Fruit
White avens <i>Geum canadense</i>	perennial	1-3'+	rhizomes	simple to palmate compound	basal	orbicular	serrate	palmate	smooth or covered with velvety hairs	flowers -- small, solitary, 5 petals, white fading to yellow
White mustard <i>Brassica hirta</i>	annual	1-2'	taproot	simple	alternate	obovate	deeply lobed, sinuate	pinnate	rough, hairy	flowers -- yellow terminal and axillary panicle
Wild cucumber <i>Echinocystis lobata</i>	annual	twining vine	fibrous	simple with opposite forked tendrils	alternate	orbicular	sharp triangular lobes	palmate	smooth	flowers -- greenish or white spike; fruit -- ovoid, green, prickled
Wild garlic <i>Allium canadense</i>	perennial	1-3'	bulb	simple	basal	narrowly linear	entire	parallel	smooth and waxy	flowers -- white flower; fruit -- little bulbs that fall to ground and root



White avens
Geum canadense



White mustard
Brassica hirta

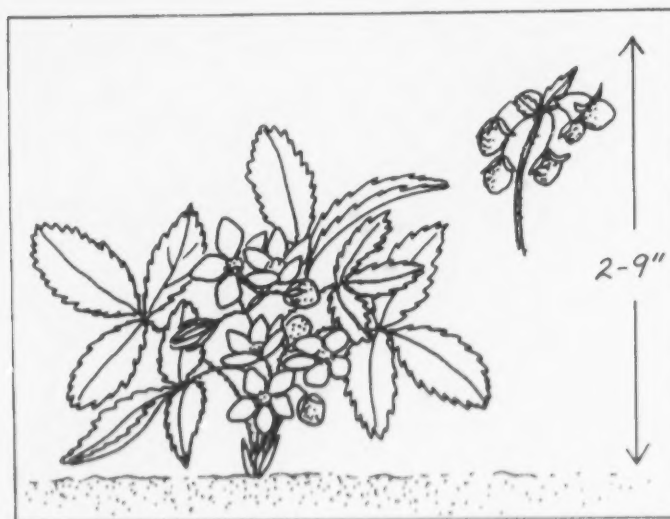


Wild cucumber
Echinocystis lobata



Wild garlic
Allium canadense

Forb Identification										
Common Name Botanical Name	Life Cycle	Plant Height	Root Structure/ Modified Stems	Leaf Type	Leaf Arrangement	Leaf Shape	Leaf Margin	Leaf Venation	Leaf Surface	Flower/Fruit
Wild strawberry <i>Fragaria virginiana</i>	perennial	2-9"	rhizomes, few stolons	compound palmate	basal	leaflets broadly obovate	serrate	pinnate leaflets	small hairs	flowers -- white, compound umbel; fruit -- small, red, fleshy, droopy, sweet

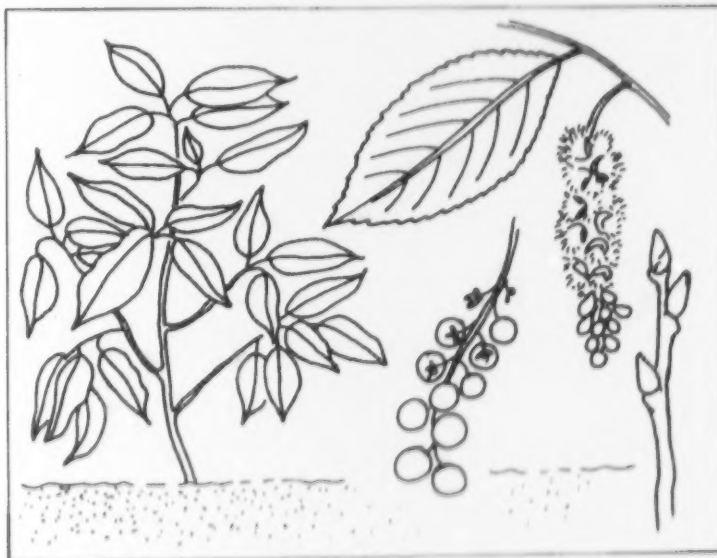


Wild strawberry
Fragaria virginiana

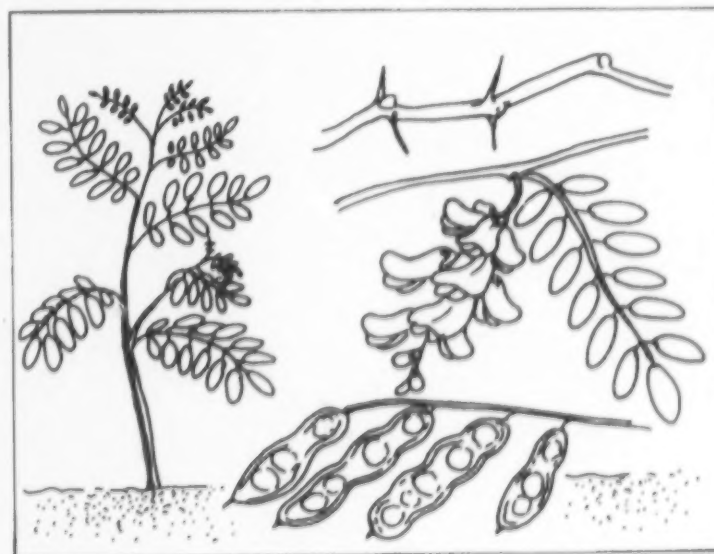
Perennial Woody Plants

Black cherry - *Prunus serotina*
Black locust - *Robinia pseudoacacia*
Black oak - *Quercus velutina*
Black raspberry - *Rubus occidentalis*
Coralberry or buckbrush - *Symphoricarpus orbiculatus*
Dewberry - *Rubus flagellaris*
Elm - *Ulmus* spp.
Flowering dogwood - *Cornus florida*
Grape - *Vitis* spp.
Hawthorn - *Crataegus* spp.
Hickory - *Carya* spp.
High bush blackberry - *Rubus pensilvanicus*
Honey locust - *Gleditsia triacanthos*
Osage orange - *Maclura pomifera*
Persimmon - *Diospyros virginiana*
Poison ivy - *Rhus radicans*
Redcedar - *Juniperus virginiana*
Rose - *Rosa* spp.
Sassafras - *Sassafras albidum*
Smooth sumac - *Rhus glabra*
White oak - *Quercus alba*
Wild plum - *Prunus* spp.
Willow oak - *Quercus phellos*

Perennial Woody Plant Identification							
Common Name Botanical Name	Primary Use	Bark Characteristics	Stem	Buds	Leaf Arrangement	Type of Leaf	Leaf Shape
Black cherry <i>Prunus serotina</i>	food for grouse, robins, thrush, bears, rabbits, chipmunks, deer	dark brown to black, scaly plates	thin and smooth with lenticels	pointed	alternate	simple	oblong
Black locust <i>Robinia pseudoacacia</i>	food for quail, deer, squirrel	brown with yellow or orange inner bark, heavily grooved	slender and dull brown, with paired thorns on the sides of fast-growing twigs	embedded in the stems	alternate	compound, 9 to 19 leaflets	orbicular
Black oak <i>Quercus velutina</i>	food for deer, bears, turkeys, prairie chickens, raccoons, blue jays, squirrels, foxes, chipmunks, woodpeckers	dark, deeply fissured	smooth, gray	5 large, egg-shaped buds angled out; covered with gray wool	alternate	simple, 4-9" long	oval
Black raspberry <i>Rubus occidentalis</i>	food for grouse, pheasant, many songbirds, deer, bears, rabbits, squirrels, chipmunks	red-purple, smooth and glaucous	erect or arching, rooting at tips, curved prickles	partially obscured by leaf base; ovoid, pubescent, red-brown	alternate	compound, 3 to 5 leaflets	ovate

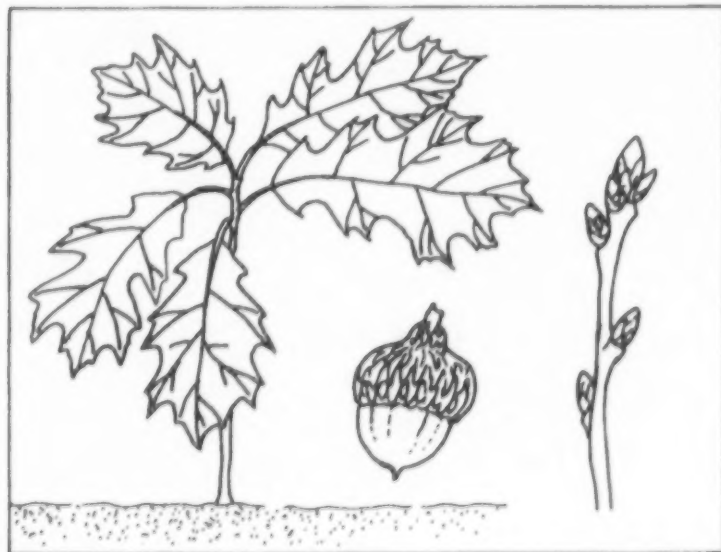


Black cherry
Prunus serotina

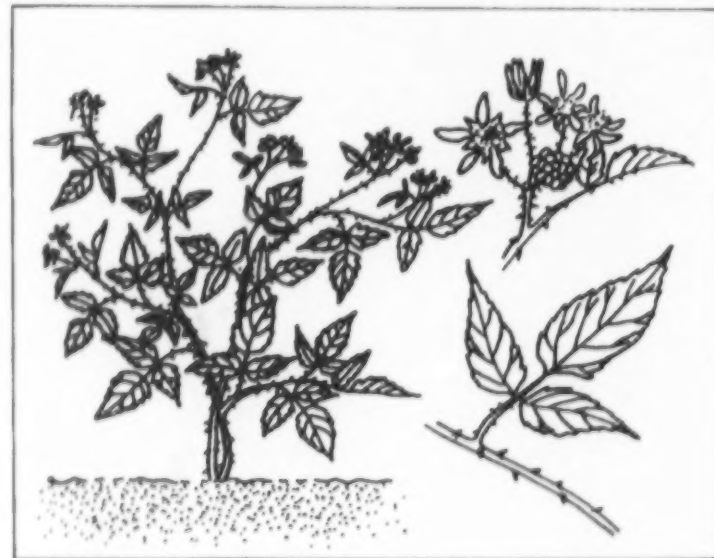


Black locust
Robinia pseudoacacia

Perennial Woody Plant Identification						
Tip Shape	Base Shape	Leaf Margin	Venation	Leaf Color	Leaf Surface	Flower/Fruit
cuspidate	cuneate	minutely serrate	pinnate	shiny dark green on upper surface, duller below	smooth upper surface, orange hair lining the midrib underneath	fruit -- clusters of dark-red, pea-sized cherries
obtuse	rounded	entire	pinnate	bluish green, yellow in fall	smooth, pubescent on midribs	flowers -- long white hanging clusters, fragrant; fruit -- flat pod 2-4" long containing 4 to 8 seeds
acute	truncate	lobed	pinnate	green on upper surface, yellow-green underneath	smooth, shiny upper surface, hairy underneath	fruit -- acorns
acuminate	rounded	coarsely serrate	pinnate	dark green on upper surface, white underneath	smooth upper surface with dense hairs underneath	flowers -- cluster of 3 to 7 white 5-petaled flowers; fruit -- glaucous purple-black berry with many small drupes



Black oak
Quercus velutina

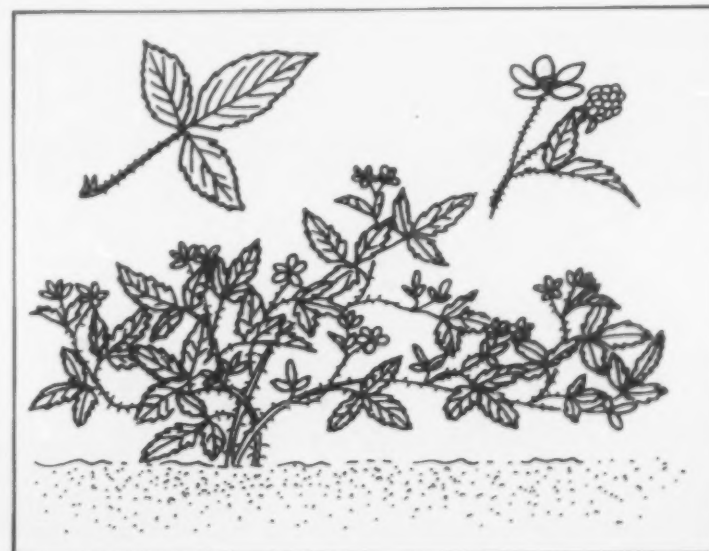


Black raspberry
Rubus occidentalis

Perennial Woody Plant Identification							
Common Name Botanical Name	Primary Use	Bark Characteristics	Stem	Buds	Leaf Arrangement	Type of Leaf	Leaf Shape
Coralberry or buckbrush <i>Symphoricarpos orbiculatus</i>	food for deer, mice, grouse, songbirds, turkeys	gray-brown, shredded	erect, brown, slender, slightly hairy	small	opposite	simple	ovate
Dewberry <i>Rubus flagellaris</i>	food for grouse, pheasant, many songbirds, deer, bears, rabbits, squirrels, chipmunks	brown	spreading, rooting at tips, curved prickles	ovoid, brown, pubescent	alternate	compound, 3 to 5 leaflets	ovate
Elm <i>Ulmus spp.</i>	food for deer, squirrels, finches	gray, rough, covered with deeply cut scales	slender, reddish brown to gray	pointed	alternate	simple, 4-6" long, 1-3" wide	orbicular
Flowering dogwood <i>Cornus florida</i>	food for deer, bears, songbirds	light gray, textured	slender, greenish to purple, pubescent in youth, scar encircling stem	terminal flower bud at stem apex, flattened and covered by 2 large scales; small slender lateral buds	opposite	simple, 3" long	ovate



Coralberry or buckbrush
Symphoricarpos orbiculatus



Dewberry
Rubus flagellaris

Perennial Woody Plant Identification						
Tip Shape	Base Shape	Leaf Margin	Venation	Leaf Color	Leaf Surface	Flower/Fruit
acute	rounded	entire	pinnate	dull green	smooth upper surface, hairy underneath	fruit -- groups of fleshy pink to red or purple drupes (4-6 mm)
acute	rounded	serrate	pinnate	dark green, often with reddish tips, paler green underneath	smooth, sometimes slightly rough, upper surface, pubescent underneath	flowers -- white, sometimes pinkish; fruit -- black, sweet, juicy
cuspidate	unevenly truncate	doubly serrated	pinnate	dark green	smooth and shiny, sometimes slightly rough	flowers -- clusters, individual flowers hanging from a long stem, reddish; fruit--clusters, single seed with papery outer covering, ½" long
acute	cuneate to round	entire, wavy	pinnate, parallel to margins	dark green, whitish underside, brilliant in fall	smooth upper surface, glaucous underneath, pubescent on veins	flowers -- before leaves, small with 4 large white bracts; fruit -- scarlet egg-shaped berries ½" long that remain throughout winter



Elm
Ulmus spp.



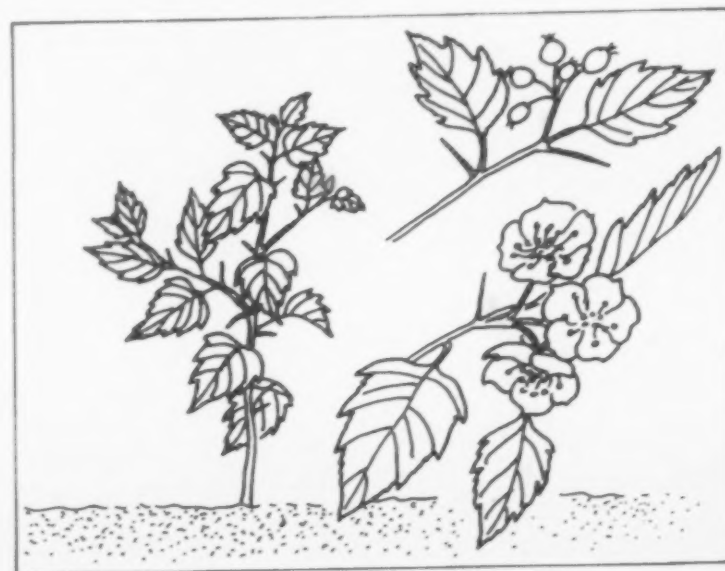
Flowering dogwood
Cornus florida

Perennial Woody Plant Identification							
Common Name Botanical Name	Primary Use	Bark Characteristics	Stem	Buds	Leaf Arrangement	Type of Leaf	Leaf Shape
Grape <i>Vitis spp.</i>	food for deer, grouse, turkeys, songbirds, mice, raccoons, opossums, skunks	loose and exfoliating, ropy	ropy with tendrils, green or dull red-brown	slender, small	alternate	simple	orbicular
Hawthorn <i>Crataegus spp.</i>	food for turkeys, songbirds, bears	gray to reddish brown	gray to reddish brown; stiff, sharp thorns, 1-3" long	reddish terminal bud with larger scales; smaller, reddish, globular, lateral buds	alternate	simple, 1-3" long	triangular, ovate
Hickory <i>Carya spp.</i>	food for chipmunks, squirrels	gray, long thin shaggy plates in older bark	gray, smooth	egg-shaped terminal bud with smooth, dark outer shell; narrow, pointed buds that can be velvety, light-colored inside	alternate	compound, 8-14" long, 5 to 7 leaflets 4-8" long	elliptical, broadest above middle
High bush blackberry <i>Rubus pensilvanicus</i>	food for quail, deer, bears, grouse, pheasants, songbirds, raccoons, chipmunks, groundhogs	canes with thorns, turning brown and red with age	green with thorns, arching	thin, long, pointed buds	alternate	compound, 3 to 5 (2½-4" long) leaflets	oval



Grape
Vitis spp.

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Hawthorn
Crataegus spp.

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Perennial Woody Plant Identification						
Tip Shape	Base Shape	Leaf Margin	Venation	Leaf Color	Leaf Surface	Flower/Fruit
cuspidate	cordate	dentate	pinnate	dull green	smooth, base may have few small hairs	fruit -- blue or blackish clusters
acute	truncate or subcordate	dentate	pinnate	dark green, paler underneath; reddish in spring, yellow in fall	smooth	flowers -- white; fruit -- small yellow to red berries
acute	cuneate	finely dentate	pinnate	dark yellow-green	smooth	flowers -- male in catkins, female in spikes; fruit -- nut
acute	rounded	coarsely dentate	pinnate	medium green on upper surface, paler underneath	rough	flowers -- white, 5 petals, 1" in diameter; fruit -- black clusters when ripe



Hickory
Carya spp.

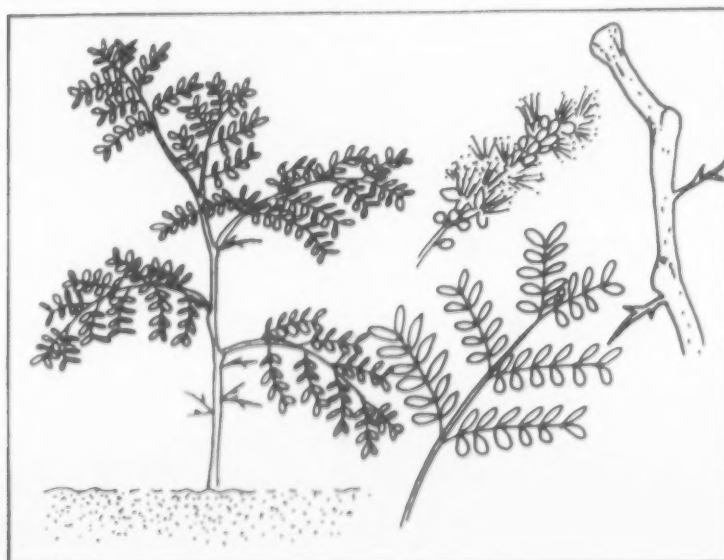
375



High bush blackberry
Rubus pensilvanicus

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Perennial Woody Plant Identification							
Common Name Botanical Name	Primary Use	Bark Characteristics	Stem	Buds	Leaf Arrangement	Type of Leaf	Leaf Shape
Honey locust <i>Gleditsia triacanthos</i>	food for quail, deer, squirrels	grayish brown to black, thick, fissured	red-brown to gray-brown, sharp thorns	terminal buds absent, axillary buds inconspicuous	alternate	compound, bipinnate with small leaflets	lanceolate
Osage orange <i>Maclura pomifera</i>	food for quail, squirrels	orange and brown, cut in strips	slender, orange-brown to tan, sharp spines	inconspicuous	alternate	simple	lanceolate
Persimmon <i>Diospyros virginiana</i>	food for deer, turkeys, opossums, foxes, raccoons	dark, broken into thick blocky sections	slender, changing from brown to gray as it matures	small, covered with 2 dark brown scales	alternate	simple, 4-6" long	oval
Poison ivy <i>Rhus radicans</i>	food for quail, deer, mice, songbirds, bears	woody vine, green to brown	slender, green	inconspicuous	alternate	compound, trifoliate	ovate

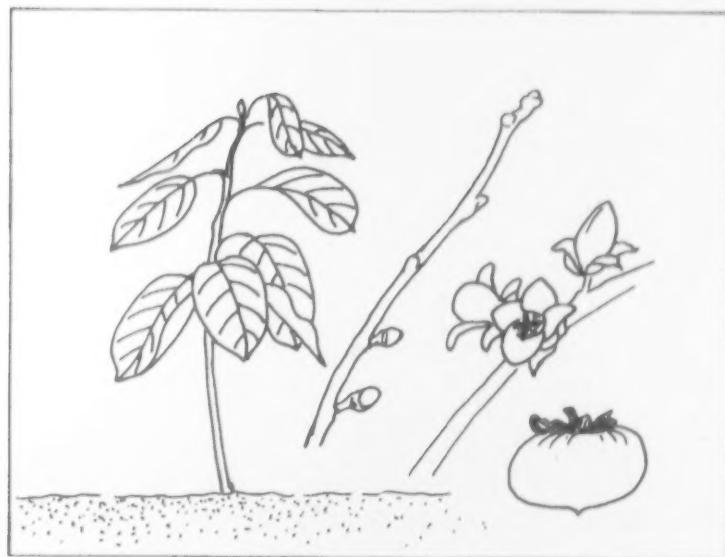


Honey locust
Gleditsia triacanthos



Osage orange
Maclura pomifera

Perennial Woody Plant Identification						
Tip Shape	Base Shape	Leaf Margin	Venation	Leaf Color	Leaf Surface	Flower/Fruit
rounded	rounded	shallowly crenate	pinnate	bright green	glabrous on upper surface, pubescent along midrib underneath	flowers - downy yellowish raceme; fruit -- flat dark brown pod 6-18" long with a single row of seeds
cuspidate	rounded	entire	pinnate	dark green on upper surface, paler underneath	smooth and shiny on upper surface, somewhat hairy underneath	fruit -- large (4-5" in diameter) cluster of small highly compressed drupes
cuspidate	rounded	entire	pinnate	dark green on upper surface, paler underneath	glossy on upper surface, woolly underneath	flowers -- yellowish to creamy white, bell-shaped male and female flowers on separate trees, clusters of 2 to 3 male flowers, solitary female flowers; fruit -- large fleshy orange berry, 1-1½" diameter
acute	rounded	lobed or incised	pinnate	dark green	smooth to slightly hairy	fruit -- cream, tan, or yellow drupe

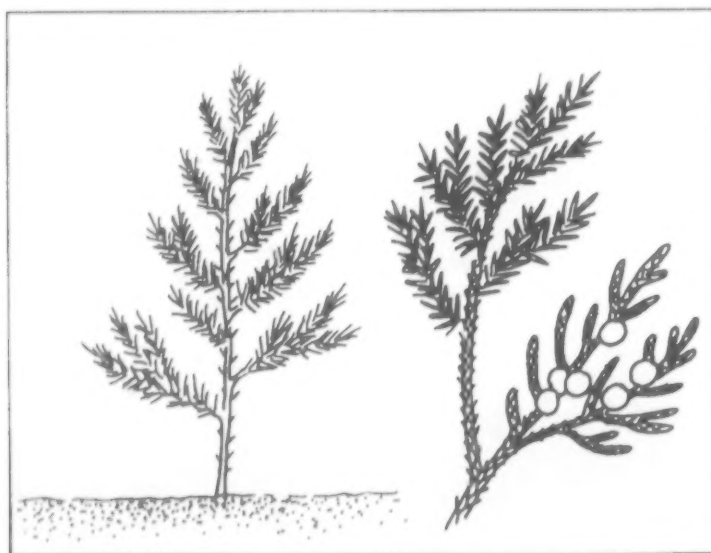


Persimmon
Diospyros virginiana

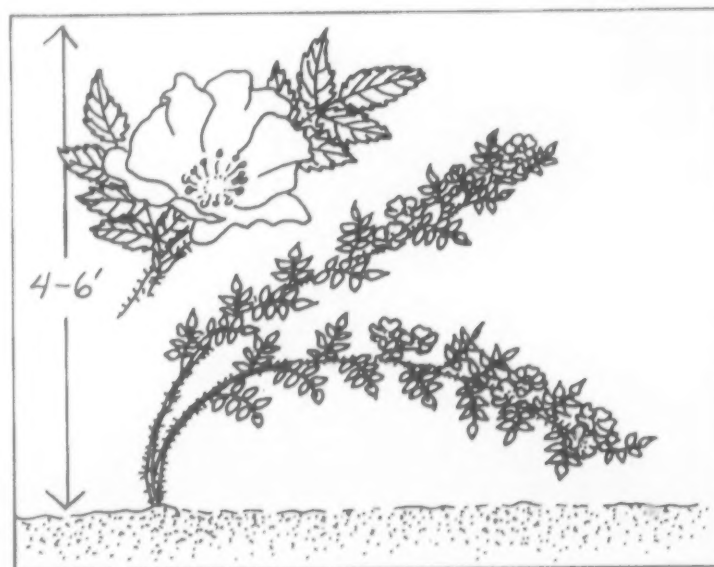


Poison ivy
Rhus radicans

Perennial Woody Plant Identification							
Common Name Botanical Name	Primary Use	Bark Characteristics	Stem	Buds	Leaf Arrangement	Type of Leaf	Leaf Shape
Redcedar <i>Juniperus virginiana</i>	food for quail, deer, turkeys, songbirds, mice	tan to reddish brown, shreddy	slender, reddish brown	inconspicuous	opposite	awl-like or scale- like	N/A
Rose <i>Rosa spp.</i>	food for deer, grouse, prairie chickens	green or brown with many prickles	slender, small prickles	large bulbous flower bud, small green leaf buds	alternate	compound, pinnate with 3 to 9 leaflets	obovate or obovate- oblong
Sassafras <i>Sassafras albidum</i>	food for quail, deer, turkeys	grey to dark brown, thick and deeply cut	medium to stout, fragrant, green to yellow with dark patches	egg-shaped, dull, pointed	alternate	simple	3 types on same tree: oval, mitten with single lobe, or mitten with double lobes
Smooth sumac <i>Rhus glabra</i>	food for deer, rabbits, songbirds	gray, thin	very stout, smooth	hairy, white	alternate	compound, pinnate with 9 to 27 leaflets	oblong

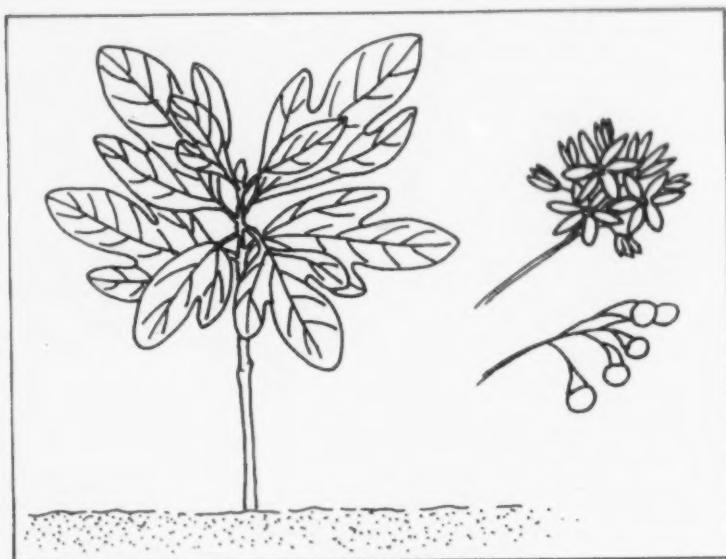


Redcedar
Juniperus virginiana



Rose
Rosa spp.

Perennial Woody Plant Identification						
Tip Shape	Base Shape	Leaf Margin	Venation	Leaf Color	Leaf Surface	Flower/Fruit
acute	N/A	entire	N/A	dark green or blue green	smooth	fruit -- pea-sized blue-gray berries
acute or obtuse	cuneate	serrate	pinnate	dark green on upper surface, paler underneath	smooth, may have soft hairs underneath	flowers -- pink with 5 petals
acute	cuneate	entire	palmate	dark green on upper surface, paler underneath	smooth with prominent veins on upper surface, smooth or few hairs underneath	flowers -- male and female flowers on separate trees; fruit -- clusters of dark blue berries on red fleshy stalks
cuspidate	rounded	dentate	pinnate	dark green on upper surface, whitish underneath; red on upper surface and purple underneath in fall	smooth	fruit -- dense clusters of berries covered with bright crimson hair

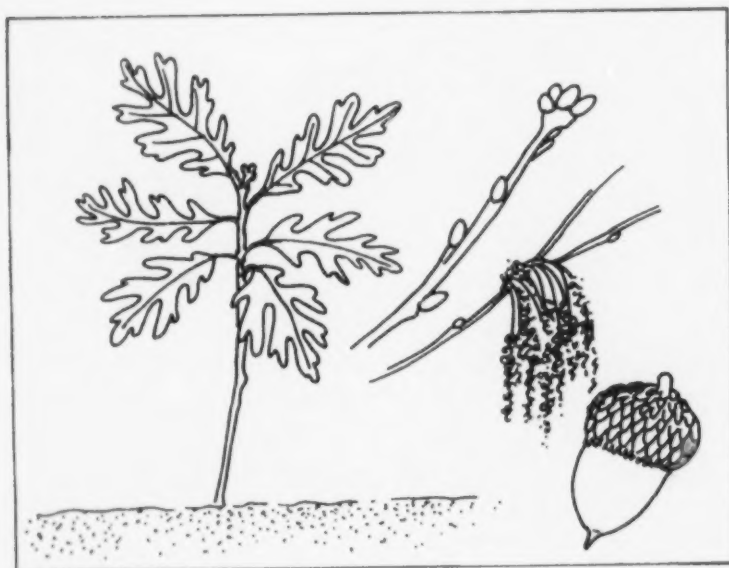


Sassafras
Sassafras albidum

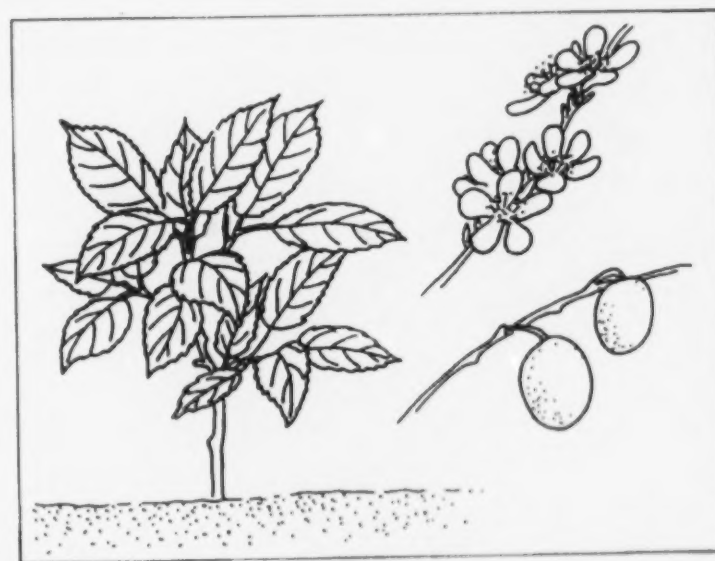


Smooth sumac
Rhus glabra

Perennial Woody Plant Identification							
Common Name Botanical Name	Primary Use	Bark Characteristics	Stem	Buds	Leaf Arrangement	Type of Leaf	Leaf Shape
White oak <i>Quercus alba</i>	food for quail, deer, turkeys, bears, prairie chickens, grouse, squirrels, songbirds, raccoons	light-gray, rough-textured with long, loose plates	light gray	clustered around stem tip, globe-shaped	alternate	simple, 5-9" long	obovate
Wild plum <i>Prunus spp.</i>	food for quail, squirrels, songbirds	thin with dark plates	slender, dark reddish brown, smooth, shiny, short thorn-like branches	small, lighter color than stem	alternate	simple	oval
Willow oak <i>Quercus phellos</i>	food for deer, turkeys, squirrels	rough and shallowly grooved	slender, smooth, dark reddish brown	smooth, 1/4" long, cone-shaped	alternate	simple, 3-5" long, 1/2-1" wide	linear

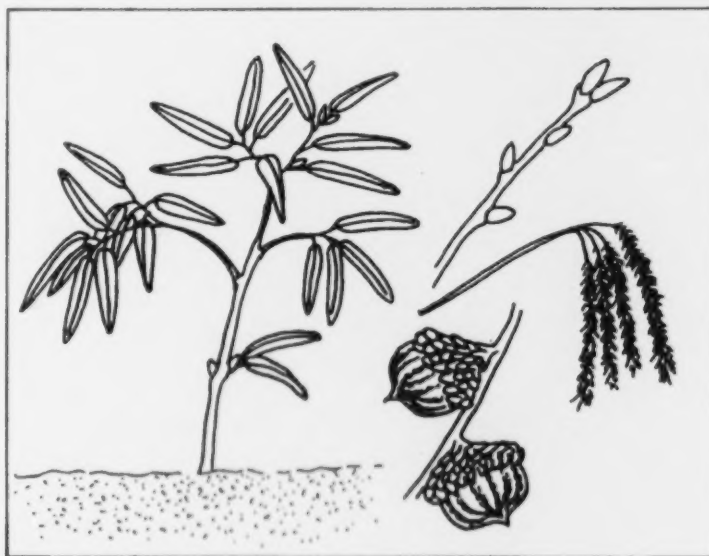


White oak
Quercus alba



Wild plum
Prunus spp.

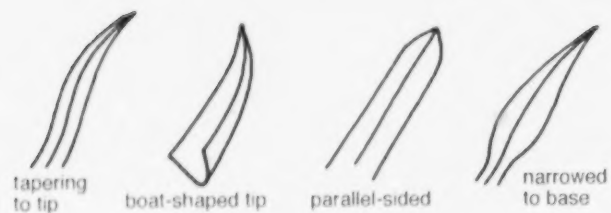
Perennial Woody Plant Identification						
Tip Shape	Base Shape	Leaf Margin	Venation	Leaf Color	Leaf Surface	Flower/Fruit
obtuse	cuneate	lobed	pinnate	bright green, whitened underneath	smooth	fruit -- ¾" long acorns
cuspidate	rounded	minutely serrate	pinnate	dark green	rough with prominent veins	flowers -- clustered, white, 1" in diameter; fruit -- red or orange, globe-shaped, 1" in diameter
acute	rounded	entire	pinnate	light green on upper surface, paler underneath	smooth, shiny	fruit -- ½" long acorns



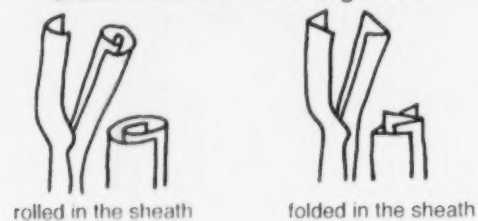
Willow oak
Quercus phellos

Illustrated Identifying Characteristics

Grass Leaf Blade Shapes



Grass Leaf Blade Arrangements



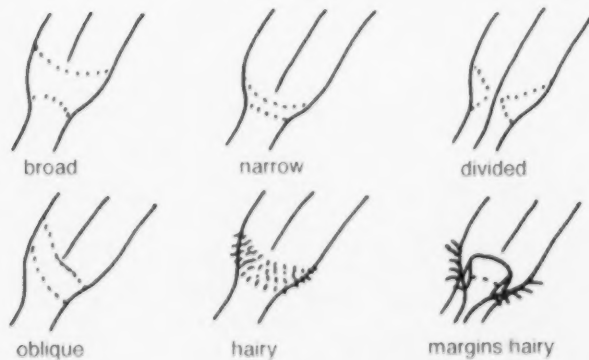
Sheath



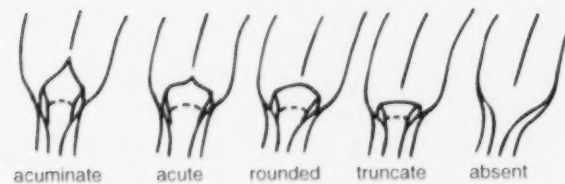
Auricles



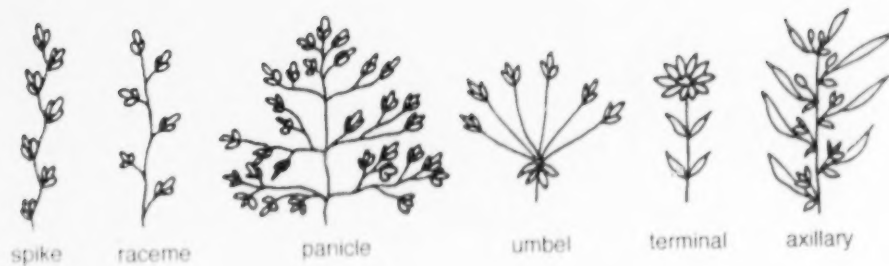
Collars



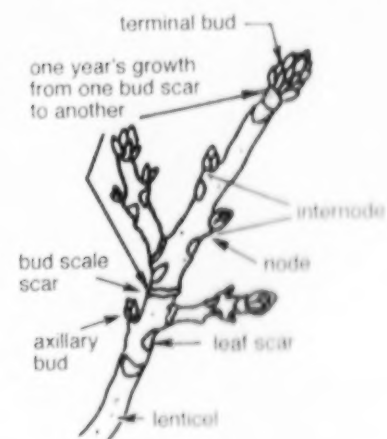
Ligules



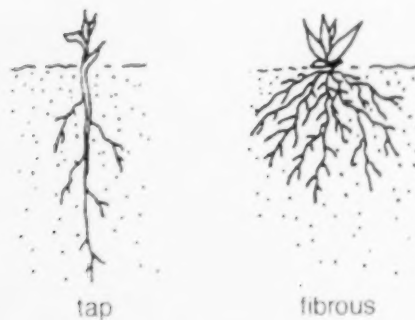
Inflorescence



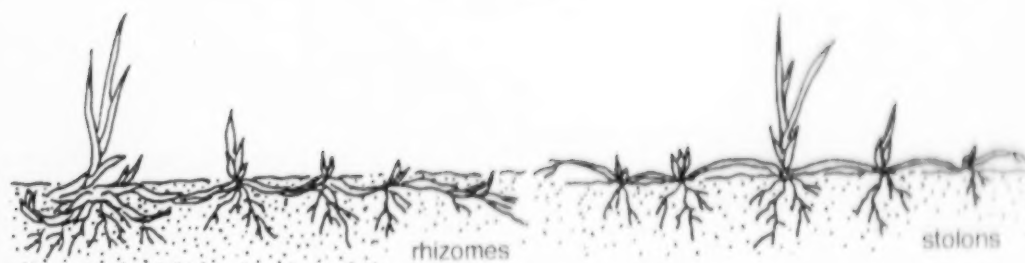
Woody Plant Stem Structure



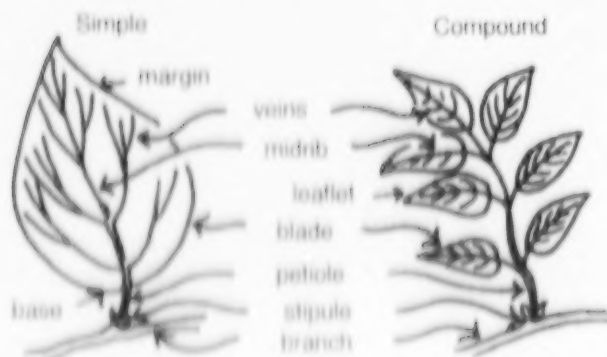
Root Structures



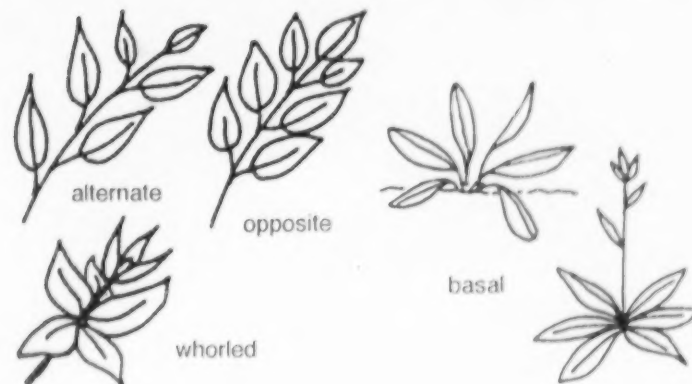
Modified Stems



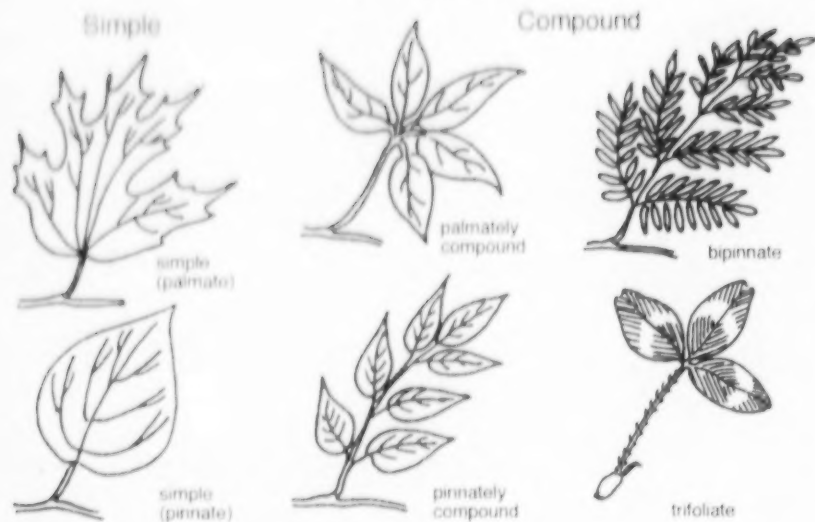
Leaf Parts



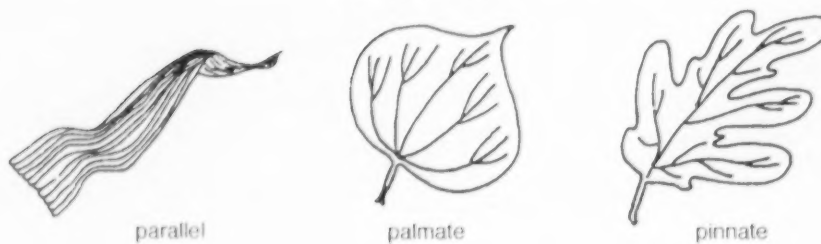
Leaf and Bud Arrangements



Leaf Types



Leaf Venation



Leaf Shapes



ovate



obovate



oblong



oval



orbicular



linear



lanceolate



oblanceolate

Common Tip Shapes



emarginate



obtuse



cuspidate



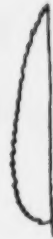
acute

Common Leaf Margins

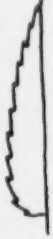
entire



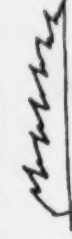
serrulate



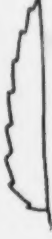
serrate



doubly serrate



dentate



crenate



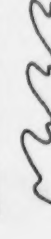
sinuate



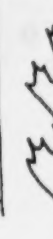
undulate



lobed



incised



Common Leaf Base Shapes



truncate



cordate



rounded



cuneate

Credits

- Barnard, Carolyn M., and Loren D. Potter. *New Mexico Grasses: A Vegetative Key*. Albuquerque: University of New Mexico Press, 1984.
- Crampton, Beecher. *Grasses in California*. Berkeley: University of California Press, 1974.
- Duncan, Wilbur H., and Marion B. Duncan. *Trees of the Southeastern United States*. Athens: University of Georgia Press, 1988.
- Gould, Frank W. *The Grasses of Texas*. College Station: Texas A&M University Press, 1975.
- Great Plains Flora Association. *Flora of the Great Plains*. Lawrence: University Press of Kansas, 1986.
- Hausman, Ethel Hinckley. *Beginner's Guide to Wild Flowers*. New York: G. P. Putnam and Sons, 1947.
- Hitchcock, A. S. *Manual of the Grasses of the United States*. 2nd ed. 2 vols. New York: Dover, 1971.
- Mohlenbrock, Robert H. *Flowering Plants: Basswoods to Spurges*. Carbondale: Southern Illinois University Press, 1982.
- Newcomb, Lawrence. *Newcomb's Wildflower Guide*. Boston: Little, Brown, and Company, 1977.
- Palmer, Bruce. *Missouri: Conservation Trees and Shrubs*. Jefferson City: Missouri Department of Conservation, 1995.
- Rickett, Theresa. *Wild Flowers of Missouri*. 2nd ed. Columbia: University of Missouri, 1954.
- Rodekahr, Sherie, and Debi Waeckerle. *Landscaping and Turf Management*. University of Missouri-Columbia: Instructional Materials Laboratory, 1990.
- Settergren, Carl, and R. E. McDermott. *Trees of Missouri*. University of Missouri-Columbia extension publication, 1991.
- Slavik, Bohumil. *Color Guide to Familiar Wild Flowers, Ferns, and Grasses*. London: Octopus Books, 1974.
- Smith, Tim E., ed. *Missouri Vegetation Management Manual*. Jefferson City: Missouri Department of Conservation, 1993.
- Stephens, H. A. *Woody Plants of the North Central Plains*. Lawrence: University Press of Kansas, 1973.
- Steyermark, Julian A. *Flora of Missouri*. Ames: Iowa State University Press, 1963.
- Steyermark, Julian A. *Spring Flora of Missouri*. Columbia, MO: Lucas Brothers, 1964.

Stubbendieck, James, Stephan L. Hatch, and Charles H. Butterfield. *North American Range Plants*. 4th ed. Lincoln: University Press of Nebraska, 1992.

Vines, Robert A. *Trees of Central Texas*. Austin: University of Texas Press, 1984.

Wharton, Mary E., and Roger W. Barbour. *Trees and Shrubs of Kentucky*. Lexington: University Press of Kentucky, 1973.

Wheaton, Howell N., and L. E. Anderson. *Identification of Grasses and Legumes*. University of Missouri-Columbia: Instructional Materials Laboratory, 1980.